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Rutherford
ELECTRONICS CO.

PULSE GENERATOR
MODEL B7D

CULVER CITY,
CALIFORNIA

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PULSE GENERATOR

MODEL B7D

Serial No. D218

Price $5.00

Rutherford
ELECTRONICS CO.
P.O. Box 472
Culver City, California

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PULSE GENERATOR

MODEL B7D

GENERAL DESCRIPTION

e model B7D is a compact, lightweight, gen-purpose pulse generator designed to meet igid requirements of a great number of re- and test applications. Exacting de- criteria, an electron tube complement of a number of tube types, and special duty cy- imiting circuitry to automatically protect utput tubes from life-shortening overloads e long periods of reliable operation with a im of maintenance and repair problems.

e model B7D simultaneously produces two s of 50 volt pulses (positive and negative ity) having repetition rates from 20 cycles econd to 2 megacycles per second, pulse de- and widths to 10,000 microseconds, rise and times which are separately and independent- ntrollable at the front panel from 15 nano- ds to approximately one (1) microsecond and missible duty factor of up to 30% at full tude.

The model B7D generates these pulse trains in the following manner. (Refer to Fig. A for time relations of the various pulses.)

The oscillator section creates a continuous train of timing pulses to establish the repetition rate of the output pulse. These timing pulses are used to start delay circuitry to produce what we shall call a start pulse. The start pulse occurs at the end of a time predetermined by the pulse delay controls. The start pulse is used to form the leading edge of the output pulse and to start another delay circuit which produces a second pulse called the stop pulse. This stop pulse occurs at the end of a time predetermined by the setting of the pulse width controls and is used to form the trailing edge of the output pulse. A clamp tube, which is cut off at the time the start pulse occurs, and back on again when the stop pulse occurs, creates what is used as a fill-in pulse between the start and stop pulses. The basic output pulse is therefore created by turning the main pulse on with the start pulse, keeping it on with the fill-in pulse, and turning it off with the stop pulse.

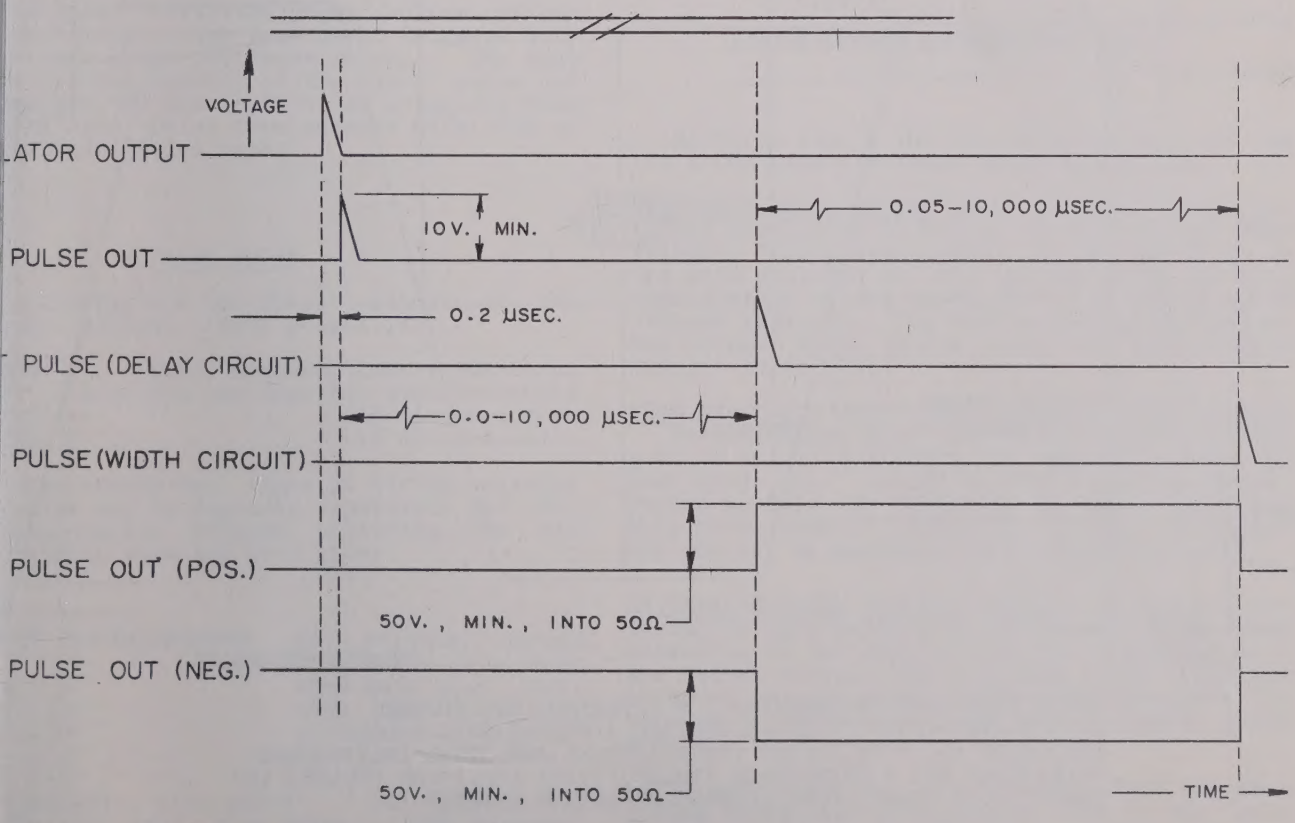


FIG. A TIMING DIAGRAM

The pulse forming circuitry then amplifies the power of this pulse and presents it through suitable attenuation and polarity determining circuitry as the main output pulse.

Supplementary circuitry furnishes a synchronizing pulse from the oscillator section for use in synchronizing additional instrumentation with the main output pulse of the generator, a means of triggering the generator from a external source so that it may be synchronized with other instruments, and a means of varying the rise and fall times of the output pulse for applications requiring a degraded pulse shape.

Past experience has indicated confusion concerning the definition of some of the basic terminology used in reference to pulses. Fig. B shows these terms as defined by accepted IRE standard pulse terminology. When used in this manual, these terms are meant to be as defined by this standard.

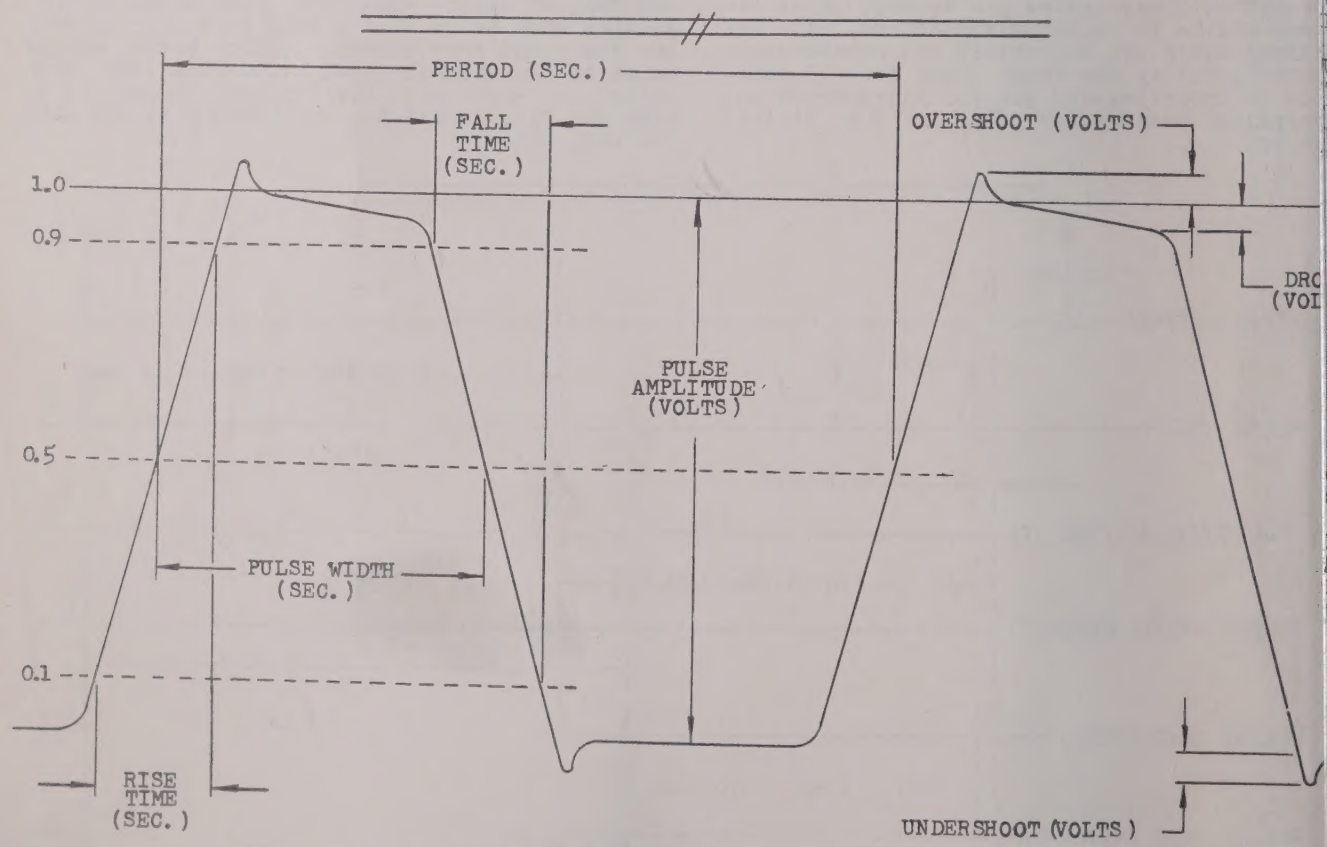
SPECIFICATIONS

The following are the design specific of the model B7D pulse generator. The i ment will, in most cases, exhibit prop which are superior to the specifications.

OSCILLATOR REPETITION RATE

The internal oscillator is continuously able from 20 cycles per second to 2 mega per second in five ranges.

20 cps	-	200 cps
200 cps	-	2 kc
2 kc	-	20 kc
20 kc	-	200 kc
200 kc	-	2 mc



REPETITION RATE (PULSES/SEC.) = 1/PERIOD (SEC./PULSE)
DUTY FACTOR (%) = PULSE WIDTH (SEC.)/PERIOD (SEC.) 100
OVERSHOOT (%) = OVERSHOOT (VOLTS)/PULSE AMPLITUDE (VOLTS) 100
UNDERSHOOT (%) = UNDERSHOOT (VOLTS)/PULSE AMPLITUDE (VOLTS) 100
DROOP (%) = DROOP (VOLTS)/PULSE AMPLITUDE (VOLTS) 100

FIG. B DEFINITIONS OF BASIC PULSE TERMINOLOGY

PULSE DELAY

pulse delay for both polarity outputs is ously variable, with respect to the sync t, from 0.0 microseconds to 10,000 mi- ds in five ranges.

0.0 µsec.	-	1.0 µsec.
1.0 µsec.	-	10 µsec.
10 µsec.	-	100 µsec.
100 µsec.	-	1,000 µsec.
1,000 µsec.	-	10,000 µsec.

PULSE WIDTH

pulse width for both polarity outputs is ously variable from 0.05 microseconds to microseconds in five ranges.

0.05 µsec.	-	1.0 µsec.
1.0 µsec.	-	10 µsec.
10 µsec.	-	100 µsec.
100 µsec.	-	1,000 µsec.
1,000 µsec.	-	10,000 µsec.

TRIGGER REQUIRED

rigger the unit from an external source, lowing trigger pulse is required.

JDE	20V., minimum.
TION RATE	2 mc, maximum.
IME	1.0 µsec. or less.
TY	Positive or negative.

At lower repetition rates and/or faster rise times, the instrument triggers with a much lower amplitude pulse. The fast rise time quality of the sync. pulse out allows the model B7D to be triggered from the sync. pulse from another model B7D at all repetition rates.

MAIN PULSE

following are the specifications of the utput pulses. (Both polarities)

JDE	50V., minimum, into a 50Ω load.
TY	Positive and negative simultaneously
IME	0.015 microseconds.
IME	0.015 microseconds.

Rise and/or fall times of either polarity pulse may be degraded separately and independently without affecting the remaining rise and fall times.

HOOT AND UNDERSHOOT	5%, maximum, except when pulse is attenuated more than 30db. with the 10db. step attenuator. 30%, maximum, at 50db. down.
0-100 µsec. wide pulse	Negligible.
100-1,000 µsec. wide pulse	15%, maximum.
1,000-10,000 µsec. wide pulse	25%, maximum.
FACTOR	30%, maximum, at full amplitude.

NOTE: Since the duty factor limiting circuitry is operated by the negative output pulse channel, it is important that the negative output be terminated in an external load of 50 ohms at all times in order to properly protect the output tubes.

ATTENUATION 0 to 60db., continuously variable.
OUTPUT IMPEDANCE 50Ω
DC LEVEL The DC level of either output pulse may be set to zero at any duty factor up to 30% by front panel control.

SYNC PULSE OUT

The following sync. pulse is available at a front panel connector.

AMPLITUDE	10V., minimum.
WIDTH	0.05 µsec., minimum.
RISE TIME	0.03 µsec., maximum.
POLARITY	Positive.

MISCELLANEOUS SPECIFICATIONS

The following are miscellaneous specifications of the instrument.

POWER REQUIRED	115V., 4.0 amps., 50-60 cps, 460 watts.
VENTILATION	Forced air.
DIMENSIONS	19" X 8 3/4" X 18 5/8".
WEIGHT, NET	58 lbs.
WEIGHT, SHIPPING	70 lbs.
ACCESSORIES INCLUDED	One Instruction Manual.

OPERATING INSTRUCTIONS

Refer to Fig. C for the location of all of the front panel controls described below.

FREQUENCY RANGE SWITCH When operated in the internal oscillator positions rotary switch S110 switches timing capacitors C110 through C119 in the grid circuits of V11 to determine the frequency range of the oscillator. In the external trigger position, the switch applies the external trigger pulse to the grid of the Schmitt trigger tube, V12.

FINE FREQUENCY AND TRIGGER SENSITIVITY CONTROL Potentiometer R115 varies the voltage at the grid of V11 to determine the repetition rate of the oscillator on any of the frequency ranges. During periods of external trigger operation this potentiometer becomes the trigger sensitivity control to determine the triggering level.

EXTERNAL TRIGGER POLARITY SWITCH In the two external trigger positions, positive or negative, depending on the polarity of the input signal, the switch selects the positive pulse from the external trigger tube, V10A, and transfers it through S110 to the input of the Schmitt trigger tube, V12.

DELAY RANGE SWITCH Rotary switch S200 switches timing capacitors C200 through C204 in the grid to ground circuit of V20A to determine the range of pulse delay.

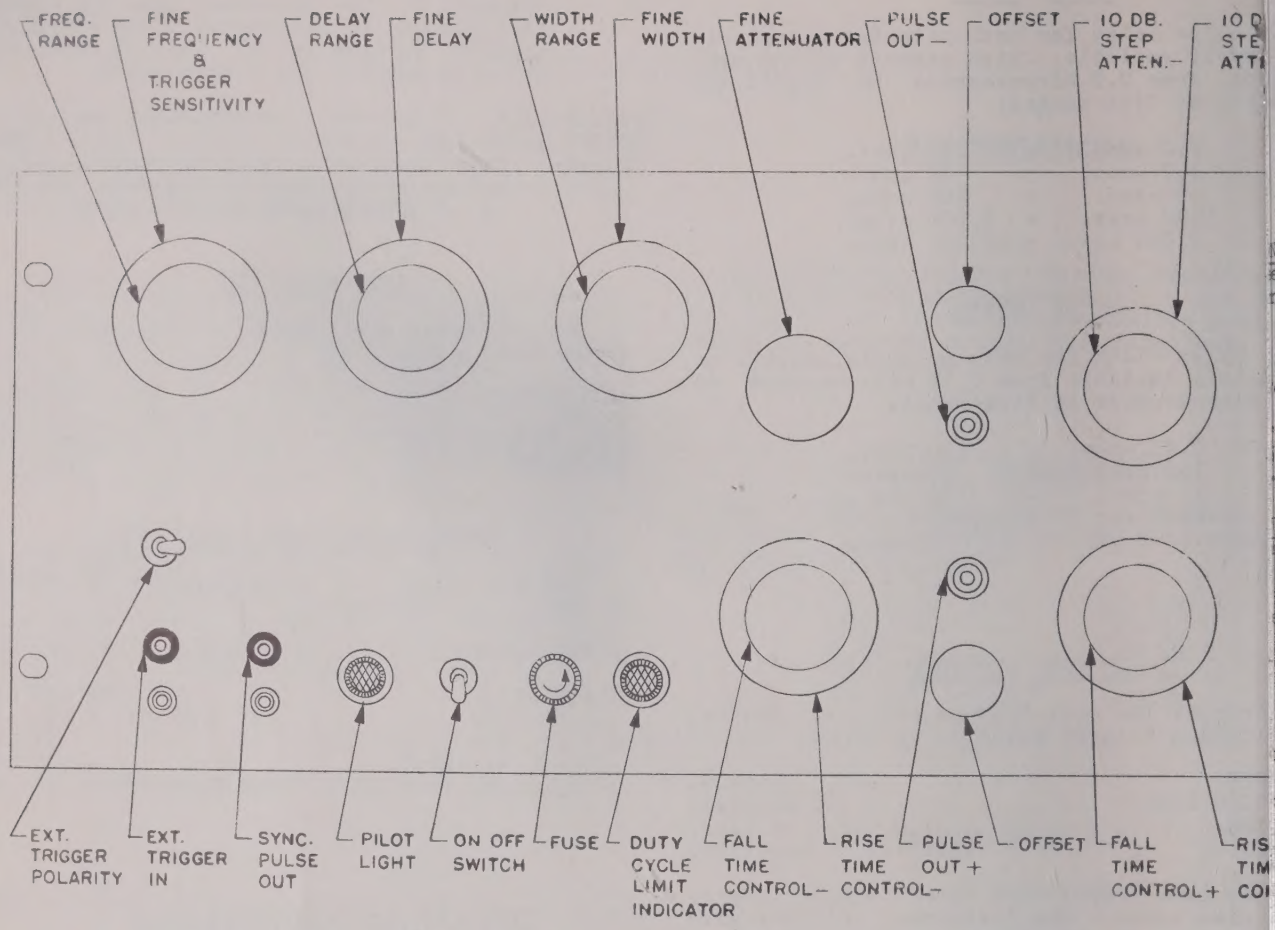


FIG. C

FINE DELAY CONTROL Potentiometer R208 varies the cathode to ground resistance of the pulse delay multivibrator, affording continuous delay settings on all delay ranges.

WIDTH RANGE SWITCH Rotary switch S300 switches timing capacitors C300 through C304 in the grid to ground circuit of V30A to determine the range of pulse width.

FINE WIDTH CONTROL Potentiometer R308 varies the cathode to ground resistance of the pulse width multivibrator, affording continuous width settings on all width ranges.

10db. STEP ATTENUATOR (NEG.) Rotary switch S800 controls the amplitude of the negative output pulse in 10db. steps.

10db. STEP ATTENUATOR (POS.) Rotary switch S801 controls the amplitude of the positive output pulse in 10db. steps.

FINE ATTENUATOR CONTROL Potentiometer R531 affords a continuously variable attenuation through each range of the 10db step attenuators.

RISE TIME CONTROL (NEG. PULSE) Potentio
R411 varies the resistance in the control
of the negative pulse output tubes, V45 and
Degradation of the negative pulse rise ti
accomplished independently of the fall tim
has no influence on rise or fall time of
positive pulse.

RISE TIME CONTROL (POS. PULSE) Potentio
R413 varies the resistance in the control
of the positive pulse output tubes, V48 and
Degradation of the positive pulse rise ti
accomplished independently of the fall tim
has no influence on rise or fall time of
negative pulse.

FALL TIME CONTROL (NEG. PULSE) Potentio
R410 varies the resistance in the control
of the negative pulse output tubes, V45 and
Degradation of the negative pulse fall ti
accomplished independently of the rise tim
has no influence on rise or fall time of
positive pulse.

FALL TIME CONTROL (POS. PULSE) Potentio
R412 varies the resistance in the control
of the positive pulse output tubes, V48 and
Degradation of the positive pulse fall ti
accomplished independently of the rise tim
has no influence on rise or fall time of
negative pulse.

Independent rise and fall time control is accomplished by use of solid state diodes in a back-to-back arrangement working in conjunction with a capacitance network. (See schematic)

AL TRIGGER IN J100 couples an external r through C100 to the control grid of the al trigger amplifier, V10A.

PULSE OUT J101 takes the synchronizing from the cathode of the sync. pulse cathollower, V10B.

LIGHT Lamp I500 lights when 115V. AC, cps, single phase power is applied to the transformer, T500.

F SWITCH Switch S500 applies power to the ry winding of the power transformer, T500.

5 ampere "slo-blo" fuse F500 protects the generator from overloads.

CYCLE LIMITING INDICATOR Lamp I530 lights the 30% duty factor limitation is exceeded. lamp, when lit, is a warning to the operathat the amplitudes of the output pulses eing automatically reduced.

Since the duty factor limiting circuitry is operated by the negative output pulse channel, it is important that the negative output be terminated in an external load of 50 ohms at all times in order to properly protect the output tubes.

PULSE OUT (NEG.) Coaxial connector J102 the negative main output pulse from the t of its 10db step attenuator.

PULSE OUT (POS.) Coaxial connector J103 the positive main output pulse from the t of its 10db step attenuator.

FFSET CONTROL (NEG.) Potentiometer R858 s the grid voltage of V55 to enable setting DC level of the negative pulse to zero at duty factors up to 30%.

FFSET CONTROL (POS.) Potentiometer R862 s the grid voltage of V56 to enable setting DC level of the positive pulse to zero at duty factors up to 30%.

CYCLE LIMIT ADJUST (Rear Panel Adjustment) ntiometer R602 sets the operating level of riable voltage regulator section in the r supply. The setting of this adjustment rmines the point at which the Duty Cycle t Indicator Light, I503 will glow and the t at which the amplitude of the output pulse ns to be reduced automatically in order to ect the output tubes.

IMINARY INSTRUCTIONS

TILATION The model B7D pulse generator is led by forced air. It is imperative that ends of the instrument be kept free of obuctions at all times in order to insure adete air flow.

It is inadvisable to operate the instrument for appreciable lengths of time with the dust covers removed. These covers not only help to keep the instrument free from dust and other foreign matter, but also properly direct the flow of air through the instrument. Therefore, if the end covers are removed and the instrument mounted in a rack, the dust cover sections must be replaced before rack mounting.

DUTY FACTOR LIMITATION The dissipation limitations of the 6DQ5 power amplifier tubes limit the duty factor of the model B7D pulse generator to 30%, i.e., at full pulse amplitude, the pulse width must never equal greater than 30% of the pulse to pulse spacing. Operation up to approximately 70% duty factor is possible with reduced pulse amplitude.

The 30% duty factor limitation is automatically controlled in the model B7D. Should the duty factor limitation be exceeded, the model B7D automatically reduces the amplitude of the outputs to such a level that the ratings of the output tubes are not exceeded. When the duty cycle limiter is in operation, the duty cycle lamp on the front panel lights, warning the operator of the reduced pulse amplitude condition.

FIRST TIME OPERATION The following procedure is recommended for putting the instrument into operation for the first time.

1. Turn the power switch to "OFF" and connect the line cord to a source of 115V., 50-60 cps power.

2. Set the instrument controls as follows:

a.	Frequency Range	200 kc
b.	Frequency	100 kc
c.	Delay Range	1 µsec.
d.	Delay	0 µsec.
e.	Width Range	10 µsec.
f.	Width	1 µsec.
g.	10db Step Attenuators	0 db.
h.	Fine Attenuators	0 db.
i.	Rise Time Controls	clockwise
j.	Fall Time Controls	clockwise

3. Connect an oscilloscope as follows:

a.	Sweep	1 µsec./cm
b.	Vertical Deflection	20 V./cm
c.	Trigger	External from the sync. out connector on the model B7D front panel.

4. Connect a ground strap from one of the model B7D ground binding posts to a ground binding post on the oscilloscope.

5. Connect a 50Ω resistive load between a pulse out connector and ground. The output impedance of the model B7D is 50Ω and it is imperative that it be properly terminated if the true output waveform is to be observed.

6. Connect the input probe of the oscilloscope across the 50Ω external load. If

the true waveform of the output pulse is to be observed, it is imperative that the oscilloscope input probe be properly compensated for viewing step function waveforms by adjusting the compensating capacitor in the probe itself and that the probe ground strap be connected to the instrument ground.

7. Turn the model B7D power switch to "ON" and allow approximately one (1) minute for the instrument to reach operating temperature. Adjust the trigger sensitivity of the oscilloscope for a stable trace. The model B7D controls may now be set to any desired values within the 30% duty factor limitation.

MAINTENANCE INSTRUCTIONS

DANGER

The power supplies in this instrument operate at voltages which are dangerous to personnel. Extreme caution must be exercised at all times. Repair or maintenance work should never be attempted unless competent personnel, thoroughly trained in the accepted methods of artificial respiration, are in attendance.

DANGER

The following maintenance suggestions are designed to aid the maintenance technician in scheduling regular preventative as well as corrective maintenance routines. It is important that maintenance routines be performed regularly to obtain maximum life and usefullness from the instrument.

FAN MOTOR The fan motor bearings require oil periodically. Use a good grade of light machine oil and apply only a drop or two every six months.

CLEANING THE INSTRUMENT At regular intervals, any dust that has settled on the interior of the instrument should be removed by means of dry compressed air. AVOID high velocity air streams which might injure the instrument or disturb adjustments. Persistent dirt may be removed with a lint-free cloth and, if necessary, carbon tetrachloride.

Under normal conditions, the silver plated contacts of the rotary switches should not require special attention. In case they become tarnished, the contacts should be cleaned by rotating the switch several times.

INSPECTION A visual inspection for loose or broken wiring, loose hardware, and discolored or deformed components is desirable while the instrument is being cleaned.

SWITCHES Turn the rotary switches while observing the contacts to check contact centering in each index position. Improperly centered contacts may be due to the switch becoming warped or twisted. AVOID pressure on the contacts as they are easily damaged.

CAPACITORS AND RESISTORS Inspect the elec tic capacitors for leakage of electrolyte, place if necessary. The wax coating of t per tubular capacitors may drip if the i ment has been overheated by operation in stricted space. This condition usually do indicate replacement.

Composition resistors should be check serious discoloration which would indicat cessive dissipation and, therefore, faulty ation. A moderate amount of discolorati normal.

RACK MOUNTING The model B7D, as purchas a portable instrument. It may, howeve mounted in a rack with other instrumentati removing the louvered end panels. To remo end panels, first remove both sections o dust cover. The six sheet metal screws hold each louvered end panel to the inn panels are now accessible. Remove these and the two screws which hold each end pan the front panel. Replace both dust cove the instrument and it is ready for rack ing. The dust covers must be put back instrument before rack mounting as they no serve to keep dust and other foreign matte of the instrument, but also help to proper rect the flow of cooling air through the i ment.

CALIBRATION The model B7D contains severa trols for the purposes of calibration, shape adjustment, etc. These controls ar set at the factory and should not require justment except due to component aging or electron tubes are replaced.

When readjustment of these controls b necessary, the instrument should be allow operate for one hour prior to adjustment i der that all components may reach their operating temperatures and the instrume reached maximum stability.

The calibration and checkout chart sh the following page is patterned after the out procedure used at the factory. The ch intended as a calibration aid only and p poses that the instrument is in proper w order, except for calibration. It shou noted that there is some interaction b many of the controls. Therefore, it is mended that the complete calibration and procedure, working from top to bottom chart, be performed at one time on a pe basis rather than spot adjustments to one cuit which could conceivably have adverse on another. Note that an asterisk (*) one column indicates that it does not which position that control is in for that ticular check.

All of the controls used for calibratio adjustment are called out by schematic number on the chassis or circuit board on they are located, with the following excep

C118 is mounted on the repetition rate

C204 is mounted on the delay switch

C304 is mounted on the width switch

R602 is adjustable through the access h the rear of the instrument.

TO CHECK OR CALIBRATE			MODEL B7D DIAL SETTINGS											OSCILLOSCOPE SETTINGS		OBSERVE	ADJUST	REMARKS
			REP. RATE		DELAY		WIDTH		ATTENUATOR		POLARITY		RISE TIME CONTROL					
			RANGE	VERNIER	RANGE	VERNIER	RANGE	VERNIER	STEP	VERNIER	OUTPUT	TRIGGER		VERTICAL	HORIZONTAL			
REP. RATE	20~-200~ 200 -2KC 2KC-20KC 20KC-200KC	HIGH END	200~-2KC	20	1	1	10	5	0	CW	*	*	CW	20V/cm	0.1millisec/cm	0.5 millisec Pulse to pulse	R111	There is some interaction between the high and low controls. Therefore, these two adjustments should be readjusted several times until both are correct. Adjustment of this range automatically adjusts the other three ranges.
		LOW END	200~-2KC	2	1	1	100	5	0		*	*	CW	20V/cm	1 millisec/cm	5 millisec Pulse to pulse	R116	
	200KC-2MC		200KC-2MC	20	1	MIN	1	MIN	0	CW	*	*	CW	20V/cm	0.1µsec/cm	0.5µsec Pulse to pulse	C118	This adjustment is to be made only after the four lower ranges have been calibrated.
	EXTERNAL TRIGGER	POSITIVE	EXT. TRIG.	SEE REMARKS	1	MIN	SEE REMARKS		0	CW	*	+	CW	20V/cm	SEE REMARKS	One output pulse for each trigger in.	NONE	Use any input trigger from 20~ to 2MC rep. rate, 20V amplitude, and rise time less than 1µsec. Oscilloscope horizontal setting and B7B width setting will depend on rep. rate. Adjust B7B rep. rate vernier for reliable triggering.
		NEGATIVE	EXT. TRIG.	SEE REMARKS	1	MIN	SEE REMARKS		0	CW	*	-	CW	20V/cm	SEE REMARKS	One output pulse for each trigger in.	NONE	
	SYNC PULSE	AMPLITUDE WIDTH RISE TIME	200KC-2MC	20	1	MIN	1	MIN	*	*	*	*	*	10V/cm	0.1µsec/cm	10V, Minimum Approx .05µsec Approx .03µsec	NONE	Looking at pulse at the sync. out jack on the instrument front panel. Polarity of the sync. pulse is positive.
PULSE DELAY	1-10 10-100 100-1,000 1,000-10,000		2KC-20KC	18	10	10	1	10	0	CW	*	*	CW	20V/cm	1µsec/cm	10µsec. - leading edge of sync pulse to leading edge of output pulse.	R200	Adjustment of this range also adjusts the three remaining longer ranges.
	0 to 1		20KC-200KC	18	1	10	1	MIN	0	CW	*	*	CW	20V/cm	0.1µsec/cm	1µsec. - leading edge of sync pulse to leading edge of output pulse.	C204	This adjustment is to be made only after the four longer ranges have been calibrated. Note that when the delay vernier is CCW the output pulse occurs coincident with or before the sync. pulse.
PULSE WIDTH	1-10 10-100 100-1,000 1,000-10,000		2KC-20KC	18	1	MIN	10	10	0	CW	*	*	CW	20V/cm	1µsec/cm	10µsec. - leading edge to trailing edge of output pulse at 50% amplitude points.	R300	Adjustment of this range also adjusts the three remaining longer ranges.
	0.05 to 1		20KC-200KC	18	1	MIN	1	10	0	CW	*	*	CW	20V/cm	0.1µsec/cm	1µsec. - leading edge to trailing edge of output pulse at 50% amplitude points.	C304	This adjustment to be made only after the four longer ranges have been calibrated. Note that when the width vernier is CCW the pulse width is 0.05µsec. or less.
OUTPUT PULSE	AMPLITUDE	POS. NEG.	20~-200~	2	1	MIN	10,000	8	0	CW	+	*	CW	20V/cm	1 millisec/cm	SEE REMARKS	R473 R479	Increase the adjustment until the amplitude of the output pulse near the trailing edge stops increasing and the leading edge starts to peak. Decrease the adjustment until the peaking just disappears.
	PULSE SHAPE	SHORT PULSE	20KC-200KC	18	1	MIN	1	5	0	CW	+	*	CW	20V/cm	0.1µsec/cm	SEE REMARKS	C260 C360 C472	Set C472 for best possible overall pulse shape. Adjust C260 and C360 for improvement. Finally, slight readjustment of all three controls will optimize the pulse shape.
		LONG PULSE	2KC-20KC	18	1	MIN	10	10	0	CW	+	*	CW	20V/cm	10µsec/cm	SEE REMARKS	C350 R354	Adjust R354 for minimum droop. Adjust C350 for optimum flatness of pulse top. Finally, slight readjustment of both controls will optimize long pulse shape.
	VERNIER	10db STEP	2KC-20KC	18	1	MIN	10	10	0	CW	+	*	CW	SEE REMARKS	1µsec/cm	SEE REMARKS	NONE	The step attenuator dial should be rotated to the various dial settings while noting that pulse amplitude decreases accordingly. Change the oscilloscope vertical setting as the attenuator is changed. At high attenuation settings, good grounding between instrument and oscilloscope becomes extremely important.
	ATTENUATOR		2KC-20KC	18	1	MIN	10	10	0	SEE REMARKS	+	*	CW	20V/cm	1µsec/cm	SEE REMARKS	SEE REMARKS	Turn attenuator vernier CCW until the output pulse decreases 10db. Pulse flatness is pre-adjusted at the factory at this setting with R353. Note, however, that R353 may be adjusted for optimum flatness at any fine attenuator (0 to 10db down) or pulse width setting. Recheck the R354 setting.
	DUTY FACTOR	200KC-2MC	200KC-2MC	20	1	MIN	1	SEE REMARKS	0	CW	+	*	CW	20V/cm	0.1µsec/cm	SEE REMARKS	R602	Set pulse width to 0.16µsec. (this is slightly in excess of 30% duty factor at 2MC). Adjust R602 to the point that pulse amplitude just starts to decrease and the duty cycle lamp on the front panel lights.
	RISE TIME	FASTEST	200KC-2MC	20	1	MIN	1	MIN	0	CW	+	*	CW	20V/cm	0.02µsec/cm	0.015µsec or less	NONE	Rise and fall times will appear to be greater than 0.015µsec. when viewed on an inferior oscilloscope. The Tektronix type N sampling unit is recommended for direct viewing of actual rise and fall times.
		DEGRADED	2KC-20KC	18			10	5					CCW		0.2µsec/cm	Approx 1µsec		
	FALL TIME	FASTEST		20	1	MIN	1	MIN	0	CW	+	*	CW	20V/cm	0.02µsec/cm	0.015µsec or less	NONE	
		DEGRADED	2KC-20KC	18			10	5					CCW		0.2µsec/cm and 5X Magnifier	Approx 1µsec		

CALIBRATION AND CHECK CHART MODEL B7D

TROUBLE SHOOTING It is of extreme importance that the operation, theory, and physical location of components be thoroughly understood before any repair of the instrument is undertaken. A careful study of the circuit descriptions and the schematic diagram will, in most instances, indicate the cause for a particular difficulty in a much shorter time than will a blind point to point check of the entire instrument. It is also suggested that whenever an operational difficulty is encountered, a recheck of the setting and adjustment of the operational controls will often times reveal that a control has been inadvertantly set in the wrong position and that this is the cause of the difficulty.

ELECTRON TUBE FAILURE A major cause of equipment failure is weak or inoperative electron tubes. When a system failure has been traced to a particular circuit, it will be found expedient to test the electron tubes in that circuit, replacing all weak or inoperative ones, before a more detailed examination of the circuit is undertaken. A HICKOCK #539A Tube Checker has been found very satisfactory in detecting electron tubes with low transconductance.

ISOLATION OF THE DEFECTIVE CIRCUIT The following trouble shooting procedure is designed to isolate the trouble to one particular circuit.

Complete failure of the instrument to operate indicates a power source difficulty. Check the source of power and make certain that the power cord plug is firmly in place. Check the fuse on the instrument front panel. A blown fuse indicates an overload condition within the instrument. Blown fuses should not be indiscriminately replaced without first ascertaining the cause of overload, as further damage is likely to result.

If power is applied to the instrument but it still fails to operate, a check should be made of the power supply voltages. For this and subsequent checks, it will be necessary to remove the dust covers from the instrument.

It will be necessary to use a synchroscope for further checks. It is important that a synchroscope with a wide band-pass be used as it is impossible to observe many of the fast rise times and narrow pulse widths on an inferior synchroscope. The Tektronix models 517, 541, 543, or 545 have been found satisfactory in observing the waveforms present in the instrument.

If the instrument has no output pulse, check for a sync. pulse at the sync. out jack on the instrument front panel. If there is no sync. pulse, the trouble is in the oscillator section of the instrument. If, however, a sync. pulse is present, synchronize a synchroscope with this pulse and proceed as follows.

Check for a pulse at the input of the attenuator switch, S800. A pulse here isolates the trouble to the switch or its components. If no pulse or a deformed pulse is present, check for a pulse at pins 3 and 6 of V40. If a normal pulse is present at this point, the faulty circuitry is in the output section.

If no pulse is present at the cathode V40, the trouble will probably be found in delay multivibrator or blocking oscillator. however, a deformed pulse is present, a stu its shape will be helpful in quickly finding cause.

If the deformed pulse shows a very slow time and normal fall time, the start pulse missing. Check the start pulse channel. there are very narrow pulses where the le and trailing edges of the output pulse w normally be, the clamp circuit is inoperat If the pulse rises normally and then immedia starts to decay slowly toward zero, the tro lies in the clamp circuit or the width mult brator circuit. Finally, if the pulse is no except for a slow fall time, check the pulse channel for faulty operation.

In checking each subsection, it is advis to start by looking for an output pulse from section and then work back toward the star the section. Thus, whenever a normal puls found, the trouble is isolated to the s which immediately follows it.

CIRCUIT DESCRIPTION

OSCILLATOR SECTION The oscillator section sists of the external trigger amplifier, the free-running multivibrator, V11; Schmitt trigger, V12; the repetition blocking oscillator, V13; and the sync. cathode follower, V10B. V10, V11, V12, an are type 6DJ8 dual triode electron tubes.

The repetition rate of the free-running tivibrator is determined by the action of front panel controls. The range of the osc tor is determined by the selection of timing pacitors C110 through C119, in the grid cir of V11, by the oscillator range switch, Fine repetition rate control of the multiv tor, through any range, is determined by va the fine frequency potentiometer, R115, varies the voltage to this grid circuit.

The limits of repetition rate for each are set with the two calibration potentiome R111 and R116, which establish the range th which this voltage may vary.

The output, taken from the plate of the tivibrator triggers the Schmitt trigger cir The Schmitt trigger circuit shapes the pu and sends it to the repetition rate blo oscillator.

The repetition rate blocking oscillator shapes the pulse. The basic repetition timing pulse is taken from the cathode of blocking oscillator and is used to trigger delay multivibrator.

external trigger amplifier provides a of triggering the instrument from an exsource. The external trigger polarity , in either the positive or negative posidepending on the polarity of the input , couples the positive pulse from V10A h the repetition rate range switch, S110, input grid of the Schmitt trigger. Pometer R115 now becomes a trigger sensitiontrol to set the triggering level. It be noted that the repetition rate switch, must be placed in the external trigger on in order to trigger the model B7D from ernal source.

timing pulse taken from the cathode of petition rate blocking oscillator is also d through a 0.2 μsec. delay line to the f the sync. pulse cathode follower. The taken from the cathode is brought to the ment front panel to be used as a synchro- pulse for use with other instrumentation. the fact that the sync. pulse occurs apately 0.2 μsec. after the pulse which rs the pulse delay circuit, we are able to me the inherent delay of the remaining try and can thus produce output pulses are not delayed in time with respect to nc. pulse.

SECTION The delay section consists of the multivibrator, V20, and the delay blocking ator, V21. V20 is a type 6DJ8 dual triode on tube and V21 is a type 6BQ7A dual trilectron tube.

monostable multivibrator, V20, is trigfrom its stable state to its quasi-stable by positive pulses from the oscillator on which are coupled into the grid of V20B e plate of V20A through diode CR201. The of time which the multivibrator remains s quasi-stable state, determined by the capacitor in the grid circuit of V20A and thode to ground resistance of V20, is the time of the circuit. Thus, this circuit mines the time between the oscillator sec- timing pulse and the start of the main .

e range of delay is determined by the seon of timing capacitors C200 through C204 e delay range switch, S200. Fine delay ol throughout any range is determined by ng the cathode to ground resistance with ine delay potentiometer, R208.

00 sets the voltage to which the grid cirs returned, thus providing calibration for arious ranges.

pulse, created by the return of the multitor to its stable state after this predeed delay, is coupled from the plate of to trigger the delay blocking oscillator,

e pulse taken from the cathode of the ing oscillator is known as the "start ". This start pulse goes to the amplifiers e start channel and to the width section it is used to trigger the width multivir.

WIDTH SECTION The pulse width section consists of the width multivibrator, V30. V30 is a type 6DJ8 dual triode electron tube.

The monostable multivibrator, V30, is triggered from its stable state to its quasi-stable state by positive pulses from the delay section which are coupled into the grid of V30B and the plate of V30A through diode CR301. The length of time which the multivibrator remains in this quasi-stable state, determined by the timing capacitor in the grid circuit of V30A and the cathode to ground resistance of V30, is the delay time of this circuit. Thus, this circuit determines the time between the delay section output pulse which starts the main pulse and the width section output pulse which stops the main pulse.

The range of pulse width, is determined by the selection of timing capacitors C300 through C304 by the width range switch, S300. Fine width control throughout any range is determined by varying the cathode to ground resistance with the fine width potentiometer, R308.

R300 sets the voltage to which the grid circuit is returned, thus providing calibration for the various ranges.

Two outputs are taken from the width multivibrator. The first is the waveform taken from the plate circuit of V30B. This waveform is a negative going pulse equal in time duration to the delay time of the width multivibrator. It is coupled through C310 to the grid of the clamp tube, V35B. The second output, a pulse created by the return of the multivibrator to its stable state after the predetermined delay, is known as the "stop pulse". This stop pulse is coupled into the amplifiers in the stop channel.

START PULSE CHANNEL The start pulse channel consists of three pulse shaping amplifier stages and the leading edge forming tube. V25 and V26 are type 7119 dual triode electron tubes. V27 is a type 6BQ7A dual triode electron tube.

The start channel receives the positive start pulse from the delay section through a 0.02 microsecond delay line, DL210. This delay line delays the start pulse without delaying the stop pulse, thus allowing a minimum output pulse width of 0.05 microseconds. This pulse goes through three pulse transformer coupled amplifier stages; V25A, V25B, and V26. Pulse transformer T260 couples the amplified pulse into the grids of the leading edge forming tube, V27. This tube drives the output pulse cathode follower, in the pulse forming section, to form the leading edge of the output pulse.

STOP PULSE CHANNEL The stop pulse channel consists of three pulse shaping amplifier stages and the trailing edge forming tube. V35A is a of a type 6BQ7A dual triode electron tube. V36 and V37 are type 7119 dual triode electron tubes.

The stop channel receives the positive stop pulse from the width section. It is sent through three stages of transformer coupled amplification; V35A, V36A, and V36B, into the grids of the trailing edge forming tube, V37. This tube drives the output pulse cathode follower, in the pulse forming section, to form the trailing edge of the output pulse.

OUTPUT SECTION The output section consists of a clamp tube, V35B, the pulse forming cathode follower, V40; two pairs of power amplifier tubes, V45 and V46 for negative pulse amplification and V48 and V49 for positive pulse amplification. In the negative pulse channel V47A acts as the grid restoration diode and V47B as the screen grid disconnect diode. Similarly, in the positive pulse channel V54A acts as the grid restoration diode and V54B as the screen grid disconnect diode. Electron tube V35B is ½ of a type 6BQ7A dual triode, V40 is a type 7119 dual triode, V45, V46, V48, and V49 are type 6DQ5 power pentodes, and V47 and V54 are type 6DJ8 dual triodes.

The clamp tube receives its input from the plate circuit of V30B in the pulse width section. During the period between output pulses, it conducts fully, holding the output at the zero level. Between the start and stop pulses it is completely cut off by the signal from the width multivibrator and holds the output pulse at full amplitude.

The grids of the pulse forming cathode follower are driven positive by the leading edge forming tube, held there by the clamp tube, and driven back to their original level by the trailing edge forming tube. From the cathodes of this tube, we take the fully shaped output pulse. This pulse is coupled through the rise time control circuitry to the control grids of the power amplifiers.

One pair of power amplifiers, V48 and V49, connected in parallel, acts as a cathode follower for a positive pulse out while a second pair of power amplifiers, V45 and V46 act as an inverting amplifier for a negative pulse out. The positive pulse out is delivered to a step attenuator which permits control of its output amplitude via S801. Similarly, the negative pulse out is delivered to a step attenuator which permits control of its output amplitude via S800.

Triode V47A, connected as a diode, provides restoration at the control grids of the negative pulse output tubes. The restoration level is adjusted by potentiometer R473. V47B, as connected, acts as the screen grid disconnect for the negative pulse output amplifiers.

Similarly, in the positive channel, triode V54A, connected as a diode, provides restoration at the control grids of the positive pulse output tubes. The restoration level is adjusted by potentiometer R479. V54B, as connected, acts as the screen grid disconnect for the positive pulse output amplifiers.

Finally, the negative and positive ou pulses are sent to their respective step att ators, S800 and S801, each consisting of 10db. constant impedance T-sections, and to pulse output jacks, J102 and J103 which are cated on the instrument front panel.

POWER SUPPLY SECTION The power supply sec contains the power transformer, T500; V50 type 0A2 voltage regulator tube; V51, a 6AS7GA dual triode electron tube; V52, a 12AX7 dual triode electron tube; V53, a type triode-pentode electron tube, and their asso ted circuitry which includes two controls varying the amplitude of the output pulse.

The power supply section furnishes five regulated DC voltages (+250V., -4V., - -18V., and -24V.), three regulated volt (+150V., -150V., and a positive variable vo age), and two sets of voltages for use in output amplifiers. For the positive out pulse amplifier it furnishes +150V. and -1 and for the negative output pulse amplifier furnishes -150V. and -300V. It also furnis filament power for all of the electron tubes the unit.

The +150V. supply is regulated by the act of V51A and V52A. The -150V. supply is regu ted by the action of the voltage regulator tu V50.

The positive variable voltage, used in places; as plate supply for the last stage start pulse amplification and as plate sup for the clamp tube; furnishes a means of va ing the amplitude of the output pulse. T supply is regulated by the action of V51B V52B. Its reference, however, is set by V53B

This reference may be varied in two wa First, it may be varied by varying the fine tenuator, R531. Secondly, it may be varied the action of the duty cycle limiting cont consisting of the circuitry of T600 and V53A.

Transformer T600 senses the ripple voltage the -150V. leg of the negative output pulse plifier power supply. This ripple voltage creases as the output amplifier draws more c rent. The bias on the control grid of V53A set at such a level by potentiometer R602 t the ripple voltage will take control of the t at the point where the power amplifiers drawing rated current and change the refere to lower the variable supply voltage. Thus, output tubes are never allowed to exceed th dissipation ratings even if the duty factor mitation is inadvertantly exceeded. At the t the variable voltage starts to decrease due duty cycle limiting, the front panel lamp I lights to warn the operator that the amplit of the output pulse is being automatically duced.

NOTE: Since the duty factor limiting circui is operated by the negative output pu channel, it is important that the ne tive output be terminated in an exter load of 50Ω at all times in order properly protect the output tubes.

CIRCUIT THEORY

is section of the manual contains explana- of several basic circuits which are used e model B7D. Inasmuch as the technician ot be totally familiar with high repetition pulse handling circuitry, it is felt that nclusion of this section in the manual will to a more thorough understanding of the in- ent.

RUNNING MULTIVIBRATOR Fig. D is a simpli- circuit of a free-running multivibrator ar to that used in the oscillator section e model B7D.

bitrarily assume that at any specified in- , triode section V1 is conducting fully and e section V2 is non-conducting because the tial at its control grid is below the cut- otential of the tube. At this instant, the voltage of V1 is lowered due to the cur- flow through V1 and R1. C2 discharges to voltage, holding V2 cut off.

ter a time determined by the discharge time through R4, the voltage potential on the of V2 reaches the cut-in potential of the V2 starts to conduct and its plate poten- drops. This drop is immediately felt at rid of V1 across C1, driving it to cut-off. late potential rises sharply and capacitor arges to the new voltage, further aiding he conduction of V2. After the initial e, V2 steadies to a low plate voltage and scharges to the cut-in potential of V1 and ycle starts over again.

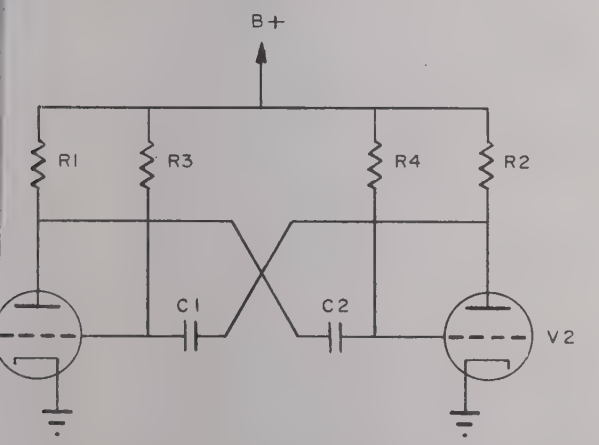


FIG. D FREE – RUNNING MULTIVIBRATOR

In summary, the operation of this circuit consists of periods of time when one tube conducts a high current while the other tube is cut off, followed by an extremely rapid change to the other tube conducting and the first tube cut off.

The repetition rate of the circuit is determined by the time constants of C1-R3 and C2-R4 and the voltage to which they are returned.

In the model B7D the range of the repetition rate of the oscillator is changed by changing the values of C1 and C2 in decade steps and the repetition rate is made continuously variable for each range by varying the level of the grid return voltage.

MONOSTABLE MULTIVIBRATOR Fig. E shows a simplified circuit of a monostable multivibrator similar to those used in the pulse delay and pulse width sections of the model B7D.

The multivibrator has one stable state and one quasi-stable state. That is, one tube section is capable of remaining in the conducting state indefinitely while the other does not have this capability. In this type of multivibrator

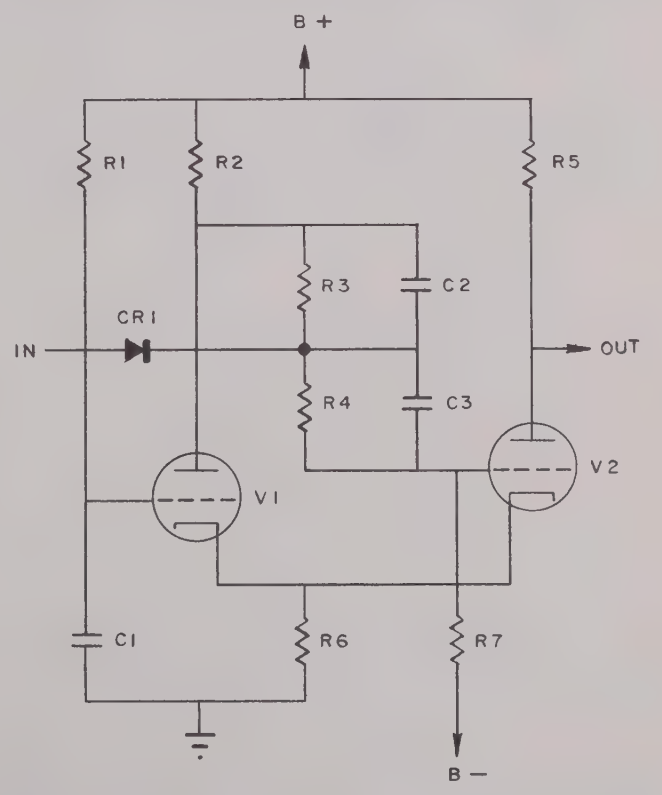


FIG. E MONOSTABLE MULTIVIBRATOR

it is necessary to trigger the circuit from its stable state to its quasi-stable state with trigger pulses from an external source. Then, the circuit will automatically return to its stable state after a certain length of time. Therefore, in operation, one triode section is triggered from non-conduction to conduction with an applied trigger. It remains in this condition for a predetermined length of time and then returns abruptly to the non-conducting state to await another trigger. Thus, we are able to generate a pulse, at a predetermined time after a given input pulse, by abruptly changing a tube section from conduction to non-conduction. Or, essentially, we have introduced a delay into the system.

Assume that the circuit is in its stable state. V1 is conducting, its grid clamped to its cathode. If R2 is made quite large, the full conduction current through V1 and thus through R6 is small and the grid is clamped near zero potential. The plate of V1, however, is at quite a low potential due to the current through the large R2. V2 is not conducting, its grid held below cut-off by the divider formed by R3, R4, and R7 between the low positive plate potential of V1 and -150 volts.

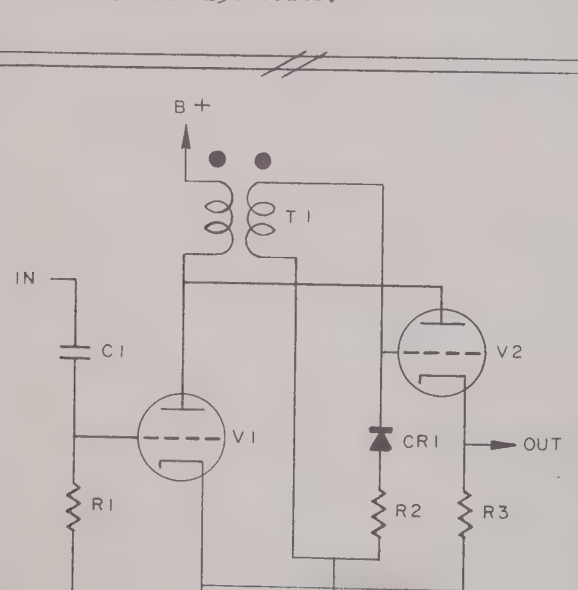


FIG. F MONOSTABLE BLOCKING OSCILLATOR

Now, at some time, a positive timing pulse arrives at the junction of the C2-R3, C3-R4 combination through diode CR1. This pulse is felt sharply across C2 and C3 at the plate of V1 and the grid of V2. V1 starts to cut off. V2 starts conducting. If R5 is small compared to R2, V2 will conduct much more heavily than V1 was conducting. The drop across R6 becomes greater due to this higher current through V2, thus the cathodes raise to a higher poten This holds V1 off completely. The plate now at a higher potential, keeps the grid above its cut-off potential by the same di network mentioned above. Thus, in a very time, a trigger pulse has changed the sta the multivibrator from that of V1 conduct small amount and V2 cut off, to one of V off and V2 conducting quite heavily.

As soon as V1 is cut off by raising it thode potential several volts with respec its grid potential, C1 starts to charge th R1 toward the B+ potential. After a time determined by the R1-C1 combination, the gr V1 will reach cut-in potential and V1 will start to conduct. The plate of V1 drops. drop is felt at the grid of V2 through C C3, immediately cutting off V2. The drop cuts V2 off also drops the cathode potent which aids the conduction of V1. C1 disch rapidly through the low grid to cathode re ance of V1, and the circuit has returned t original stable state. At the transition of V2 conducting to non-conducting, the waveform of V2 goes sharply positive. waveform is taken as the output. Thus, we produced a pulse, delayed from the ori trigger pulse, by a time predetermined by R

In the model B7D the range of delay o pulse delay and pulse width multivibrator changed by changing the value of C1 in de steps. Delay and width are made continu variable through any range by varying R6, varies the cathode potential in the quasi-st state, thus determining the potential which grid must reach to cut V1 on and return the tivibrator to its stable state.

BLOCKING OSCILLATOR Fig. F shows a ty blocking oscillator circuit such as is used the model B7D oscillator and pulse delay tions.

This blocking oscillator is a so-called stable or driven type. That is, it is not running, but requires a trigger from an exte source to excite it. It produces a high p ed, extremely sharp, narrow pulse which i sentially independent of the shape or deg tion of the pulse which triggers it.

V1 serves to amplify the input trigger a eliminate the possibility of a reaction b blocking oscillator back on the trigger source.

In the quiescent condition, both sectio the tube are biased below cut-off. A posi trigger is coupled through C1 to the ampli tube, V1, which inverts and amplifies it. transformer T1 inverts and applies this wav to the grid of V2, the blocking oscillator V2 conducts causing a drop in its plate vol The drop in plate voltage in turn causes an crease in grid viltage, which results in a ther decrease in plate voltage. Due to t loop gain of the circuit being greater than ty, regeneration occurs. The plate drive ruptly downward and the grid abruptly up This action continues until such time a loop gain drops below unity, due to the linearity of the tube.

e plate and grid cannot remain at the
s attained by the regenerative action de-
ed above because of the low frequency char-
istics of the transformer. The grid starts
op due to its finite magnetizing induc-
. When the grid voltage has dropped far
h that the loop gain once again equals uni-
a regenerative action once again occurs in
irection to turn the tube off.

overshoot occurs at the plate and grid of
ube. At the conclusion of the pulse there
ill a current flowing in the magnetizing
tance of the transformer. Since this cur-
cannot change instantaneously, it continues
ow through the effective capacitance of the
former after the tube current has dropped
ro, causing this overshoot.

e pulse width and rise time are dependent
t entirely on the design of the transfor-
. The pulse transformers used in the model
locking oscillators are specifically de-
d to produce extremely narrow, fast rise
pulses.

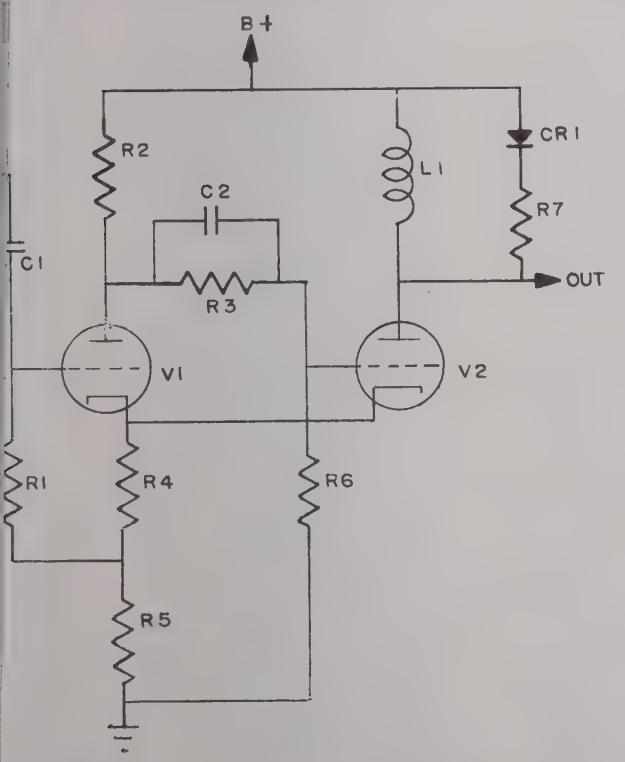


FIG. G SCHMITT TRIGGER

In the oscillator and pulse width sections of the model B7D, blocking oscillators such as described above are used. In both of these cases, a positive pulse is taken from the cathode as the output pulse.

SCHMITT TRIGGER Figure "G" shows a typical Schmitt trigger circuit such as is used in the model B7D oscillator section.

The Schmitt trigger is a monostable circuit. That is, it is not free-running but requires a trigger from an external source to excite it. This circuit produces an extremely sharp pulse which is essentially independent of the amplitude and waveform of the pulse which triggers it.

In the quiescent condition, V2 is conducting, V1 is not conducting, its grid held below cut-off by the divider network formed by R4 and R5 between the cathodes of V1 and V2 and ground. A positive trigger is coupled through C1 to the grid of V1, causing the tube to conduct. For an instant, the voltage across the cathode resistors increases, driving the grid of V2 towards cut-off. This, in addition to the drop in plate voltage of V1, causes a rapid change in V2 from conducting to a cut-off condition. V2 will remain cut off until the input signal has decreased to the cut-off value of V1. As soon as V1 is cut off by the changing input signal, the plate voltage of V1 will rise, causing the voltage on the grid of V2 to rise, and V2 conducts.

Thus, in a short time the circuit has been triggered between its two stable states by a trigger pulse whose amplitude exceeded a definite positive value and changed to a definite less positive value.

PARTS LIST

ABBREVIATIONS

cer	ceramic	m	milli or 10^{-3}	PT	paper tubular
comp	composition	meg	megohm or 10^{6} ohms	SET	solid electrol
EMC	electrolytic, metal cased	MF	metal film		tantalum
EMT	electrolytic, metal tubular	μ	micro or 10^{-6}	SM	silvered mica
f	farad	μμ	micromicro or 10^{-12}	V	working volts,
GMV	guaranteed minimum value	Ω	ohm	var	variable
h	henry	prec	precision	W	watt
k	kilohm or 10^{3} ohms			WW	wire wound

CAPACITORS

C100	.01 μf	fixed	cer	500V	GMV
C101	.01 μf	fixed	cer	500V	GMV
C102	.01 μf	fixed	cer	500V	GMV
C103	.01 μf	fixed	cer	500V	GMV
C104	.01 μf	fixed	cer	500V	GMV
C105	.01 μf	fixed	cer	500V	GMV
C110	.47 μf	fixed	mylar	150V	± 1%
C111	.47 μf	fixed	mylar	150V	± 1%
C112	.047 μf	fixed	mylar	150V	± 1%
C113	.047 μf	fixed	mylar	150V	± 1%
C114	4700μμf	fixed	SM	500V	± 1%
C115	4700μμf	fixed	SM	500V	± 1%
C116	470μμf	fixed	SM	500V	± 1%
C117	470μμf	fixed	SM	500V	± 1%
C118	5-80μμf	var	mica	175V	
C119	47μμf	fixed	SM	500V	± 5%
C120	100μμf	fixed	cer	500V	±10%
C121	5μμf	fixed	SM	500V	± 5%
C122	.01 μf	fixed	cer	500V	GMV
C123	.01 μf	fixed	cer	500V	GMV
C130	100μμf	fixed	cer	500V	±10%
C131	.01 μf	fixed	cer	500V	GMV
C132	.01 μf	fixed	cer	500V	GMV
C200	.47 μf	fixed	mylar	150V	± 1%
C201	.047 μf	fixed	mylar	150V	± 1%
C202	4700μμf	fixed	SM	500V	± 1%
C203	470μμf	fixed	SM	500V	± 1%
C204	5-80μμf	var	mica	175V	
C205	.01 μf	fixed	cer	500V	GMV
C206	100μμf	fixed	SM	500V	± 5%
C207	100μμf	fixed	SM	500V	± 5%
C208	100μμf	fixed	cer	500V	±10%
C209	.01 μf	fixed	cer	500V	GMV
C210	100μμf	fixed	cer	500V	±10%
C211	.01 μf	fixed	cer	500V	GMV
C212	.01 μf	fixed	cer	500V	GMV
C213	.01 μf	fixed	cer	500V	GMV
C250	.01 μf	fixed	cer	500V	GMV
C260	1.5-7μμf	var	cer	500V	
C261	.01 μf	fixed	cer	500V	
C300	.47 μf	fixed	mylar	150V	
C301	.047 μf	fixed	mylar	150V	
C302	4700μμf	fixed	SM	500V	
C303	470μμf	fixed	SM	500V	
C304	5-80μμf	var	mica	175V	
C306	100μμf	fixed	SM	500V	
C307	100μμf	fixed	SM	500V	
C308	100μμf	fixed	cer	500V	
C309	2 μf	fixed	EMT	450V	-1
C310	.25 μf	fixed	MP	200V	
C311	.01 μf	fixed	cer	500V	
C350	4-30μμf	var	cer	500V	
C351	.01 μf	fixed	cer	500V	
C352	.01 μf	fixed	cer	500V	
C360	4-30μμf	var	cer	500V	
C361	.01 μf	fixed	cer	500V	
C362	.01 μf	fixed	cer	500V	
C363	.01 μf	fixed	cer	500V	
C400	.5 μf	fixed	MP	600V	
C401	.01 μf	fixed	cer	500V	
C404	.03 μf	fixed	cer	500V	
C405	2 μf	fixed	EMT	450V	-1
C406	.5 μf	fixed	MP	600V	
C407	.01 μf	fixed	cer	500V	
C450	20 μf	fixed	EMT	350V	-1
C451	.01 μf	fixed	cer	500V	
C452	33μμf	fixed	SM	500V	
C453	22μμf	fixed	SM	500V	
C454	20 μf	fixed	EMT	350V	-1
C455	.01 μf	fixed	cer	500V	
C460	20 μf	fixed	EMT	350V	-1
C461	.01 μf	fixed	cer	500V	
C462	33μμf	fixed	SM	500V	
C463	20 μf	fixed	EMT	350V	-1
C464	.01 μf	fixed	cer	500V	

C470	.25 µf	fixed	MP	200V	±20%
C471	.01 µf	fixed	cer	500V	GMV
C472	9-180µµf	var	mica	175V	
C473	.01 µf	fixed	cer	500V	GMV
C474	.25 µf	fixed	MP	200V	±20%
C475	.25 µf	fixed	MP	200V	±20%
C476	2 µf	fixed	EMT	450V	-10+50%
C500	80-80 µf	fixed	EMC	350V	-10+50%
C501	80-80 µf	fixed	EMC	350V	-10+50%
C502	80-80 µf	fixed	EMC	350V	-10+50%
C503	.1 µf	fixed	PT	400V	±20%
C520	.1 µf	fixed	PT	400V	±20%
C521	2 µf	fixed	EMT	450V	-10+50%
C522	.1 µf	fixed	PT	400V	±20%
C523	2 µf	fixed	EMT	450V	-10+50%
C530	.1 µf	fixed	PT	400V	±20%
C531	.1 µf	fixed	PT	400V	±20%
C540	200-200 µf	fixed	EMC	250V	-10+50%
C541	200-200 µf	fixed	EMC	250V	-10+50%
C542	200-200 µf	fixed	EMC	250V	-10+50%
C600	50 µf	fixed	EMT	25V	-10+100%
C601	200-200 µf	fixed	EMC	250V	-10+50%
C602	200-200 µf	fixed	EMC	250V	-10+50%
C603	200-200 µf	fixed	EMC	250V	-10+50%
C604	200-200 µf	fixed	EMC	250V	-10+50%
C700	1500 µf	fixed	EMC	50V	-10+50%
C801	2 µf	fixed	MP	200V	±20%
C804	2 µf	fixed	MP	200V	±20%
C805	22µµf	fixed	cer	1KV	±20%
C806	20 µf	fixed	EMT	450V	-10+50%
C807	.1 µf	fixed	cer	75 V	GMV
C808	20 µf	fixed	EMT	450V	-10+50%
C809	.1 µf	fixed	cer	75 V	GMV
C810	.01 µf	fixed	cer	500V	GMV

CHOKES

L120	75 µh	fixed	±10%
L200	25 µh	fixed	±10%
L300	25 µh	fixed	±10%

CONNECTORS

J100		nylon binding post
J101		nylon binding post
J102	UHF	type SO239
J103	UHF	type SO239

DELAY LINES

DL100	fixed	.2 µsec
DL210	fixed	.02 µsec

CR120			type 1N116
CR130			type 1N34A
CR200			type 1N34A
CR201			type 1N116
CR210			type 1N34A
CR250			type 1N774
CR251			type 1N774
CR300			type 1N34A
CR301			type 1N116
CR350			type 1N774
CR360			type 1N774
CR361			type 1N774
CR370			type 1N98
CR371			type 1N98
CR372			type 1N98
CR373			type 1N98
CR374			type 1N98
CR375			type 1N98
CR376			type 1N98
CR377			type 1N98
CR378			type 1N98
CR379			type 1N98
CR380			type 1N98
CR381			type 1N98
CR500	Rectifier, Silicon	200ma	360PIV
CR501	Rectifier, Silicon	200ma	360PIV
CR502	Rectifier, Silicon	200ma	360PIV
CR503	Rectifier, Silicon	200ma	360PIV
CR504	Rectifier, Silicon	200ma	360PIV
CR505	Rectifier, Silicon	200ma	360PIV
CR530	Rectifier, Silicon	200ma	360PIV
CR550	Zener		type SCL
CR551	Zener		type SCL
CR552	Zener		type SCL
CR553	Zener		type SCL

DIODES

CR600	Rectifier, Silicon	500ma	400PIV
CR601	Rectifier, Silicon	500ma	400PIV
CR602	Rectifier, Silicon	500ma	400PIV
CR603	Rectifier, Silicon	500ma	400PIV
CR604	Rectifier, Silicon	200ma	360PIV
CR700	Rectifier, Silicon	200ma	360PIV
CR701	Rectifier, Silicon	200ma	360PIV

ELECTRON TUBES

V10		
V11	type	6DJ8
V12	type	6DJ8
V13	type	6DJ8
	type	6DJ8
V20		
V21	type	6DJ8
	type	6BQ7A

V25	type	7119
V26	type	7119
V27	type	6BQ7A
V30	type	6DJ8
V35	type	6BQ7A
V36	type	7119
V37	type	7119
V40	type	7119
V45	type	6DQ5
V46	type	6DQ5
V47	type	6DJ8
V48	type	6DQ5
V49	type	6DQ5
V50	type	0A2
V51	type	6AS7GA
V52	type	12AX7
V53	type	6U8A
V54	type	6DJ8
V55	type	12B4A
V56	type	12B4A

FUSE

F500	5amp	Slo-Blo

LAMPS

I500	#47
I530	NE51

RESISTORS

R100	150k	fixed	comp	½W	±10%
R101	1k	fixed	comp	½W	±10%
R102	10k	fixed	comp	½W	±10%
R103	1k	fixed	comp	½W	±10%
R104	1k	fixed	comp	½W	±10%
R105	680Ω	fixed	comp	½W	±10%
R110	1k	fixed	comp	1W	±10%
R111	10k	var	comp	2W	±20%
R112	1k	fixed	comp	1W	±10%
R113	75k	fixed	comp	½W	± 5%
R114	75k	fixed	comp	½W	± 5%
R115	10k	var	comp	2W	±20%
R116	5k	var	comp	1W	±20%
R117	4.7k	fixed	comp	2W	±10%
R120	6.8k	fixed	comp	½W	±10%
R121	470Ω	fixed	comp	½W	±10%
R122	150k	fixed	comp	½W	±10%
R123	1meg	fixed	comp	½W	±10%
R124	1.2k	fixed	comp	½W	±10%
R125	6.8k	fixed	comp	½W	±10%
R126	68k	fixed	comp	½W	±10%
R127	39k	fixed	comp	½W	±10%
R128	3.3meg	fixed	comp	½W	±10%
R130	470Ω	fixed	comp	½W	±10%
R131	1k	fixed	comp	1W	±10%
R132	1k	fixed	comp	½W	±10%
R200	100k	var	comp	1W	±20%
R201	100k	fixed	comp	½W	±10%
R202	47Ω	fixed	comp	½W	±10%
R203	470Ω	fixed	comp	½W	±10%
R204	100k	fixed	prec	½W	± 1%
R205	27k	fixed	comp	½W	±10%
R206	12k	fixed	comp	½W	±10%
R207	220Ω	fixed	comp	2W	±10%
R208	500Ω	var	comp	2W	±20%
R209	300k	fixed	comp	½W	± 5%
R210	470Ω	fixed	comp	½W	±10%
R211	3.3k	fixed	comp	½W	±10%
R212	470Ω	fixed	comp	2W	±10%
R250	1k	fixed	comp	½W	±10%
R251	150Ω	fixed	comp	½W	±10%
R252	330Ω	fixed	comp	½W	±10%
R260	1k	fixed	comp	2W	±10%
R261	1k	fixed	comp	2W	±10%
R300	100k	var	comp	1W	±20%
R301	100k	fixed	comp	½W	±10%
R302	47Ω	fixed	comp	½W	±10%
R303	470Ω	fixed	comp	½W	±10%
R304	100k	fixed	prec	½W	± 1%
R305	27k	fixed	comp	½W	±10%
R306	12k	fixed	comp	½W	±10%
R307	470Ω	fixed	comp	2W	±10%
R308	500Ω	var	comp	2W	±20%
R309	300k	fixed	comp	½W	± 5%
R350	470K	fixed	comp	½W	±10%
R351	3.3k	fixed	comp	½W	±10%
R352	330Ω	fixed	comp	½W	±10%
R353	250k	var	comp	2W	±30%
R354	50k	var	comp	2W	±30%
R355	150k	fixed	comp	½W	±10%
R356	68k	fixed	comp	2W	±10%
R357	10k	fixed	comp	½W	±10%
R360	330Ω	fixed	comp	½W	±10%
R361	330Ω	fixed	comp	½W	±10%
R400	22k	fixed	comp	2W	±10%
R410	25k	var	comp	2W	±30%
R411	10k	var	comp	2W	±30%
R412	25k	var	comp	2W	±30%
R413	10k	var	comp	2W	±30%
R414	56Ω	fixed	comp	½W	±10%
R415	33Ω	fixed	comp	½W	±10%
R450	10Ω	fixed	comp	2W	±10%
R451	10Ω	fixed	comp	2W	±10%
R452	47Ω	fixed	comp	½W	±10%
R453	100Ω	fixed	comp	½W	±10%
R454	47Ω	fixed	comp	½W	±10%
R460	10Ω	fixed	comp	2W	±10%
R461	10Ω	fixed	comp	2W	±10%
R462	47Ω	fixed	comp	½W	±10%
R463	47Ω	fixed	comp	½W	±10%
R470	1meg	fixed	comp	½W	±10%
R471	1.5k	fixed	comp	1W	±10%

R472	4.7k	fixed	comp	2W	±10%
R473	5k	var	comp	2W	±30%
R474	3.3k	fixed	comp	2W	±10%
R475	100Ω	fixed	comp	½W	±10%
R476	1meg	fixed	comp	½W	±10%
R477	1.5k	fixed	comp	½W	±10%
R478	4.7k	fixed	comp	2W	±10%
R479	5k	var	comp	2W	±30%
R480	3.3k	fixed	comp	2W	±10%
R500	100k	fixed	comp	½W	±10%
R501	3k	fixed	WW	10W	±10%
R502	150k	fixed	comp	1W	±10%
R510	10Ω	fixed	comp	½W	±10%
R511	73.2k	fixed	prec	½W	± 1%
R512	68.1k	fixed	prec	½W	± 1%
R513	10Ω	fixed	comp	½W	±10%
R514	220k	fixed	comp	½W	± 5%
R515	150k	fixed	comp	½W	± 5%
R516	1.5k	fixed	WW	25W	±10%
R520	220k	fixed	comp	½W	±10%
R521	4.70k	fixed	comp	½W	±10%
R522	22k	fixed	comp	2W	±10%
R530	270k	fixed	comp	½W	± 5%
R531	250k	var	comp	2W	±20%
R532	680k	fixed	comp	½W	±10%
R533	120k	fixed	comp	½W	±10%
R534	100k	fixed	comp	½W	±10%
R535	6.8k	fixed	comp	2W	±10%
R536	6.8k	fixed	comp	2W	±10%
R600	.75Ω	fixed	WW	5W	± 5%
R601	3.3meg	fixed	comp	½W	±10%
R602	50k	var	comp	1W	±30%
R603	15k	fixed	comp	½W	±10%
R604	100k	fixed	comp	½W	±10%
R605	100k	fixed	comp	½W	±10%
R700	47Ω	fixed	comp	2W	± 5%
R701	160Ω	fixed	comp	2W	± 5%
R702	33Ω	fixed	comp	1W	± 5%
R703	33Ω	fixed	comp	1W	± 5%
R704	33Ω	fixed	comp	1W	±10%
R705	160Ω	fixed	comp	2W	±5%
R800	270Ω	fixed	MF	8W	± 5%
R801	270Ω	fixed	MF	8W	± 5%
R802	270Ω	fixed	MF	8W	± 5%
R803	75Ω	fixed	MF	6W	± 5%
R804	75Ω	fixed	MF	6W	± 5%
R805	75Ω	fixed	MF	6W	± 5%
R810	2ea 52Ω	fixed	MF	6W	± 5%
R811	26Ω	fixed	MF	6W	± 5%
R812	2ea 70Ω	fixed	MF	6W	± 5%
R813	270Ω	fixed	MF	8W	± 5%
R814	270Ω	fixed	MF	8W	± 5%
R815	270Ω	fixed	MF	8W	± 5%
R816	2ea 52Ω	fixed	MF	6W	± 5%
R817	26Ω	fixed	MF	6W	± 5%
R818	2ea 70Ω	fixed	MF	6W	± 5%
R820	26Ω	fixed	MF	4W	± 5%
R821	26Ω	fixed	MF	4W	± 5%
R822	35Ω	fixed	MF	4W	± 5%
R823	26Ω	fixed	MF	4W	± 5%
R824	26Ω	fixed	MF	4W	± 5%
R825	35Ω	fixed	MF	4W	± 5%

R830	27Ω	fixed	comp	½W	± 5%
R831	27Ω	fixed	comp	½W	± 5%
R832	36Ω	fixed	comp	½W	± 5%
R833	27Ω	fixed	comp	½W	± 5%
R834	27Ω	fixed	comp	½W	± 5%
R835	36Ω	fixed	comp	½W	± 5%
R840	27Ω	fixed	comp	½W	± 5%
R841	27Ω	fixed	comp	½W	± 5%
R842	36Ω	fixed	comp	½W	± 5%
R843	27Ω	fixed	comp	½W	± 5%
R844	27Ω	fixed	comp	½W	± 5%
R845	36Ω	fixed	comp	½W	± 5%
R850	27Ω	fixed	comp	½W	± 5%
R851	27Ω	fixed	comp	½W	± 5%
R852	36Ω	fixed	comp	½W	± 5%
R853	27Ω	fixed	comp	½W	± 5%
R854	27Ω	fixed	comp	½W	± 5%
R855	36Ω	fixed	comp	½W	± 5%
R856	180Ω	fixed	comp	2W	±10%
R857	820k	fixed	comp	½W	± 5%
R858	100k	var	comp	2W	±20%
R859	470k	fixed	comp	½W	± 5%
R860	470Ω	fixed	WW	10W	±10%
R861	73.2k	fixed	prec	½W	± 1%
R862	100k	var	comp	2W	±20%
R863	68k	fixed	comp	½W	± 5%

SWITCHES

S100	SPDT	Ext. Trig. Pol. Toggle
S110	B7B-B-519	RUTHERFORD
S200	B7B-B-520	RUTHERFORD
S300	B7B-B-520	RUTHERFORD
S500	SPST	On-Off Toggle
S800	B7B-B-521	RUTHERFORD
S801	B7B-B-521	RUTHERFORD

THERMISTOR

RT500	0.5-4Ω	25W
RT501	0.5-4Ω	25W

TRANSFORMERS

T130	B7-501	RUTHERFORD
T210	B7-501	RUTHERFORD
T250	B7-502	RUTHERFORD
T251	B7-504	RUTHERFORD
T260	B7-504	RUTHERFORD
T350	B7-502	RUTHERFORD

T360	B7-502	RUTHERFORD
T361	B7-504	RUTHERFORD
T500	B7-D-500	RUTHERFORD
T501	F-65-U	TRIAD
T600	#45753	TRIAD

FB401	56-590-65/3B	FERROXCUBE
FB450	56-590-65/3B	FERROXCUBE
FB451	56-590-65/3B	FERROXCUBE
FB460	56-590-65/3B	FERROXCUBE
FB461	56-590-65/3B	FERROXCUBE

REPLACEMENT OF COMPONENTS

In the event that component replacement becomes necessary, it is strongly recommended, in order to avoid considerable delay and unnecessary expense, that such replacement components be purchased from your local electronics supplier. A large majority of the components used in the instrument are standard electronic components and little difficulty should be encountered in replacing them.

Certain components, manufactured to RUTHERFORD ELECTRONICS CO.'S specifications, may not be readily available through local suppliers. These components should be ordered from our factory.

MANUALS AND REPAIR PARTS When ordering a manual please indicate the instrument model number and its serial number and date of original purchase. For spare parts we suggest, (1) a careful description of the part, (2) the model number and serial number of the instrument and date of original purchase. If possible, please identify parts in relation to the schematic, giving data shown on the circuit schematic diatram.

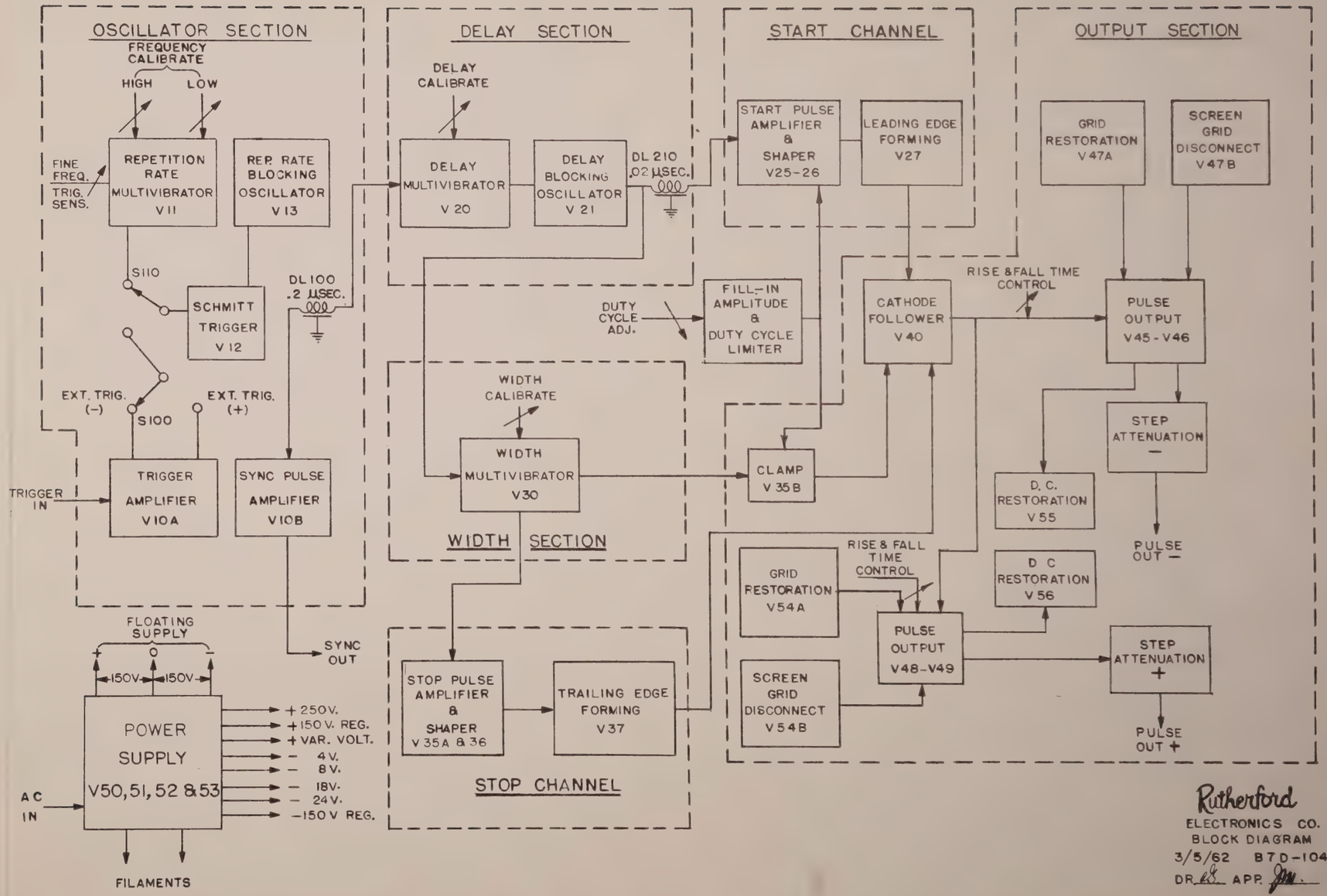
WARRANTY

RUTHERFORD ELECTRONICS CO. guarantees to the original purchaser for a period of one (1) year, EXCEPT vacuum tubes which are guaranteed for ninety days, that this instrument is free from defects in material and workmanship. Our liability is limited to repair or replacement of this instrument, or any part thereof, providing failure is not due to misuse or abnormal conditions.

In order to receive service under this wa
ranty, promptly advise the factory of all de
tails pertinent to failure of the instrume
Replacement parts will be shipped via air trans
portation if requested, prepaid to any point i
the continental United States. Should it be de
sirable to return the instrument, ship it pre
paid to the factory, and it will be serviced a
required and returned via surface transporta
tion, prepaid.

The RUTHERFORD ELECTRONICS CO. reserves th
right not to honor warranty on any instrume
with modifications done by the user. Befo
modifying, it is suggested that the modificati
be forwarded to the RUTHERFORD ELECTRONICS C
for their approval, if it is desired to keep th
instrument in its remaining warranty perio
Send a schematic of the circuit under modifica
tion and an explanation of what will be don
In return, the RUTHERFORD ELECTRONICS CO. wi
evaluate your proposal and inform you as to it
warranty position.

Service required after the expiration of wa
ranty, or because of misuse or abnormal cond
tions will be billed at cost.



LTR.	DATE	CO. NO.	BY

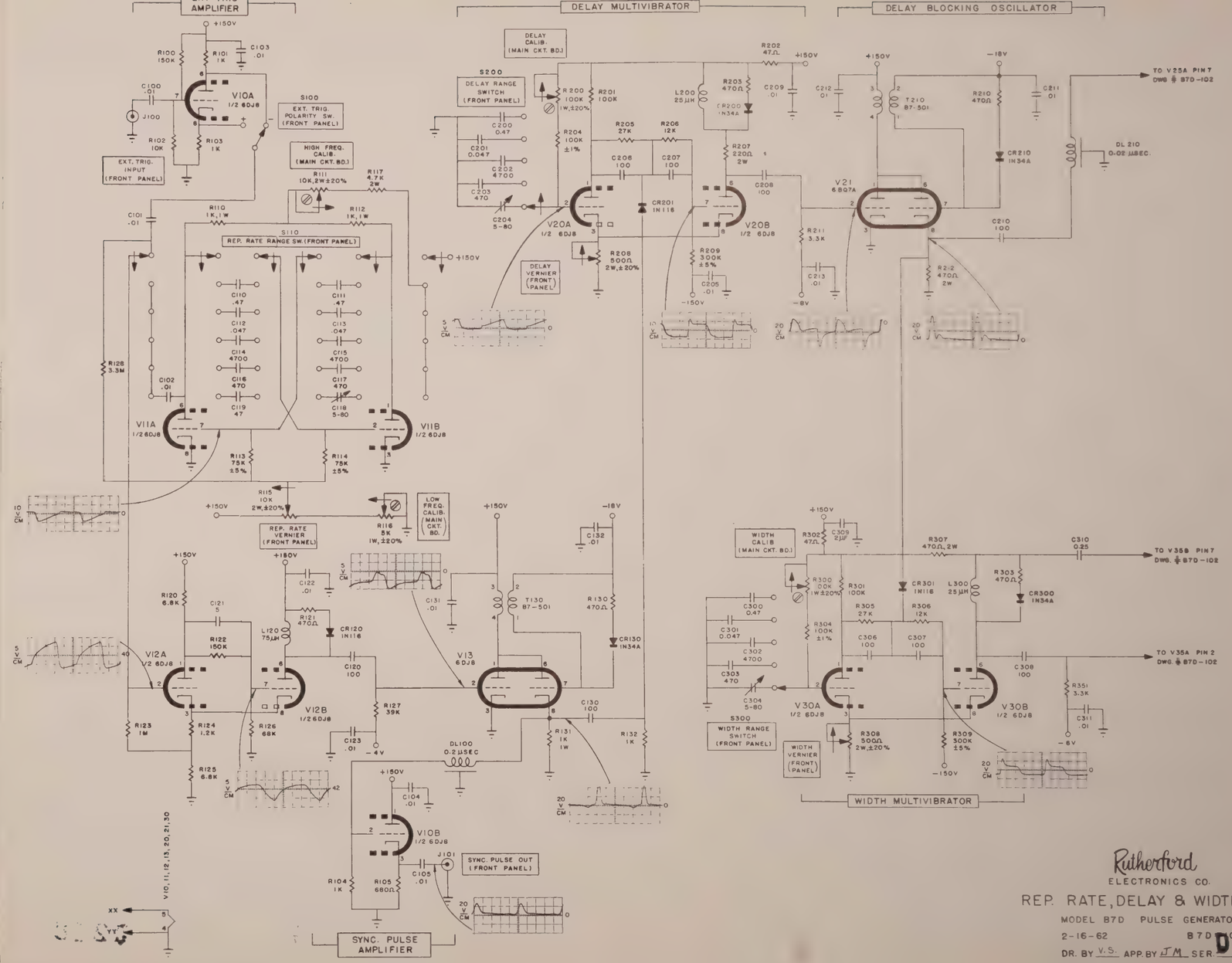
Rutherford
ELECTRONICS CO.
BLOCK DIAGRAM
3/5/62 BTD-104
DR. [illegible] APP. [illegible]

NOTES: UNLESS OTHERWISE SPECIFIED,

1. ALL FIXED RESISTORS ARE 1/2 WATT ±10%
2. ALL CAPACITOR VALUES ONE (1) OR LESS ARE IN MICROFARADS, THOSE GREATER THAN ONE (1) ARE IN MICROMICROFARADS.

WAVEFORMS

PULSE GENERATOR SETTING:	REP. RATE	2 MC
	DELAY	0.1 μSEC
	WIDTH	0.15 μSEC.
OSCILLOSCOPE SETTING:	TIME/CM	0.1 μSEC
(TEKTRONIX TYPE 541A)	VOLTS/CM	AS SPECIFIED



LTR.	DATE	CHANGE	BY	APP.

Rutherford
ELECTRONICS CO.

REP. RATE, DELAY & WIDTH SECT.

MODEL B7D PULSE GENERATOR

2-16-62 B7D 0218

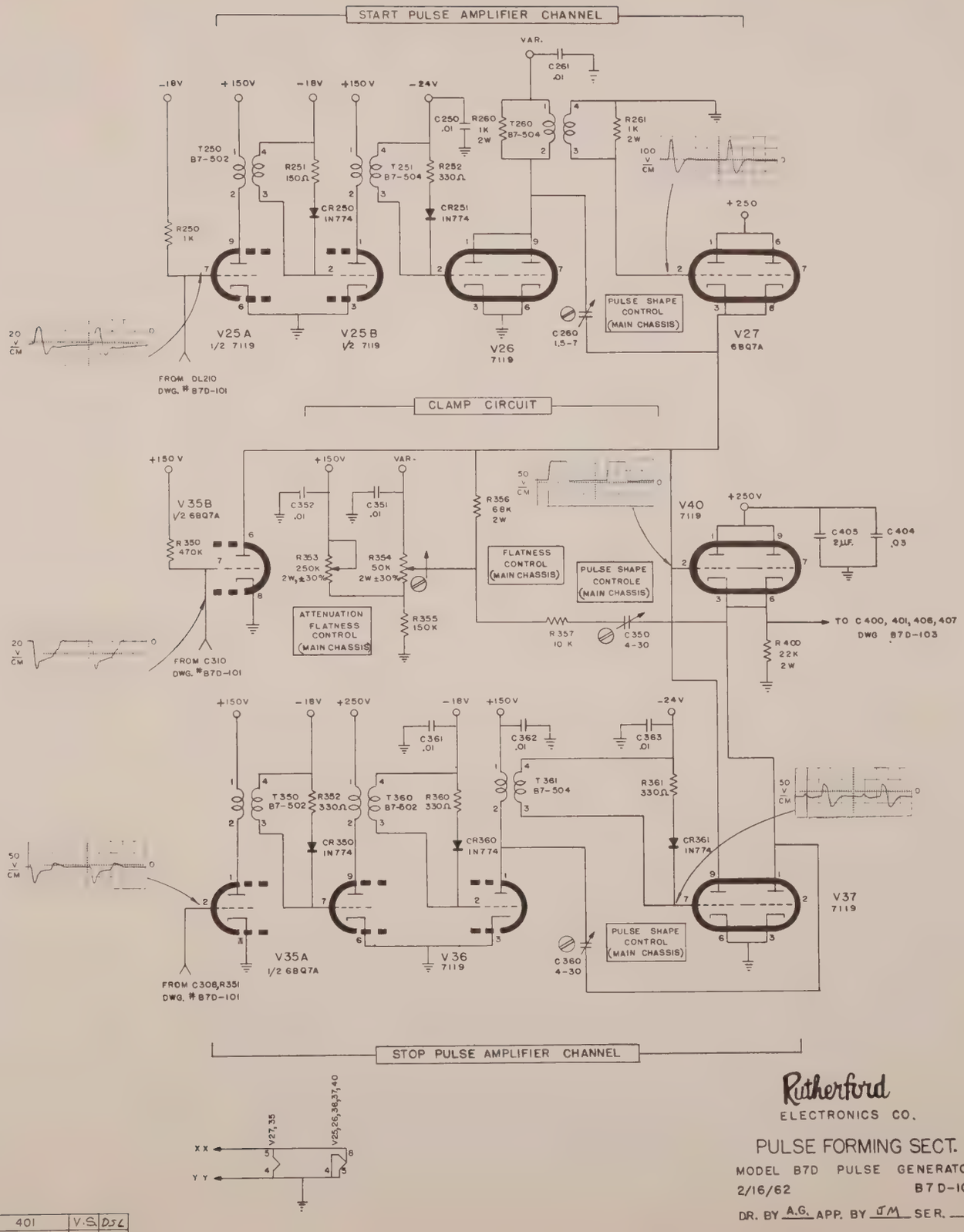
DR. BY V.S. APP. BY J.M. SER.

NOTES: UNLESS OTHERWISE SPECIFIED,

1. ALL FIXED RESISTORS ARE 1/2 WATT, ±10%
2. ALL CAPACITOR VALUES ONE (1) OR LESS ARE IN MICROFARADS
   THOSE GREATER THAN ONE (1) ARE IN MICROMICROFARADS

WAVEFORMS

PULSE GENERATOR SETTING	REP RATE	2 MC
	DELAY	0.1 μSEC
	WIDTH	0.15 μSEC
OSCILLOSCOPE SETTING	TIME/CM	0.1 μSEC
(TEKTRONIX TYPE 541A)	VOLTS/CM	AS SPECIFIED



A	7-13-62	401	V.S.	DSL
CH. LTR.	DATE	C.O. NO.	BY	APP.

Rutherford
ELECTRONICS CO.

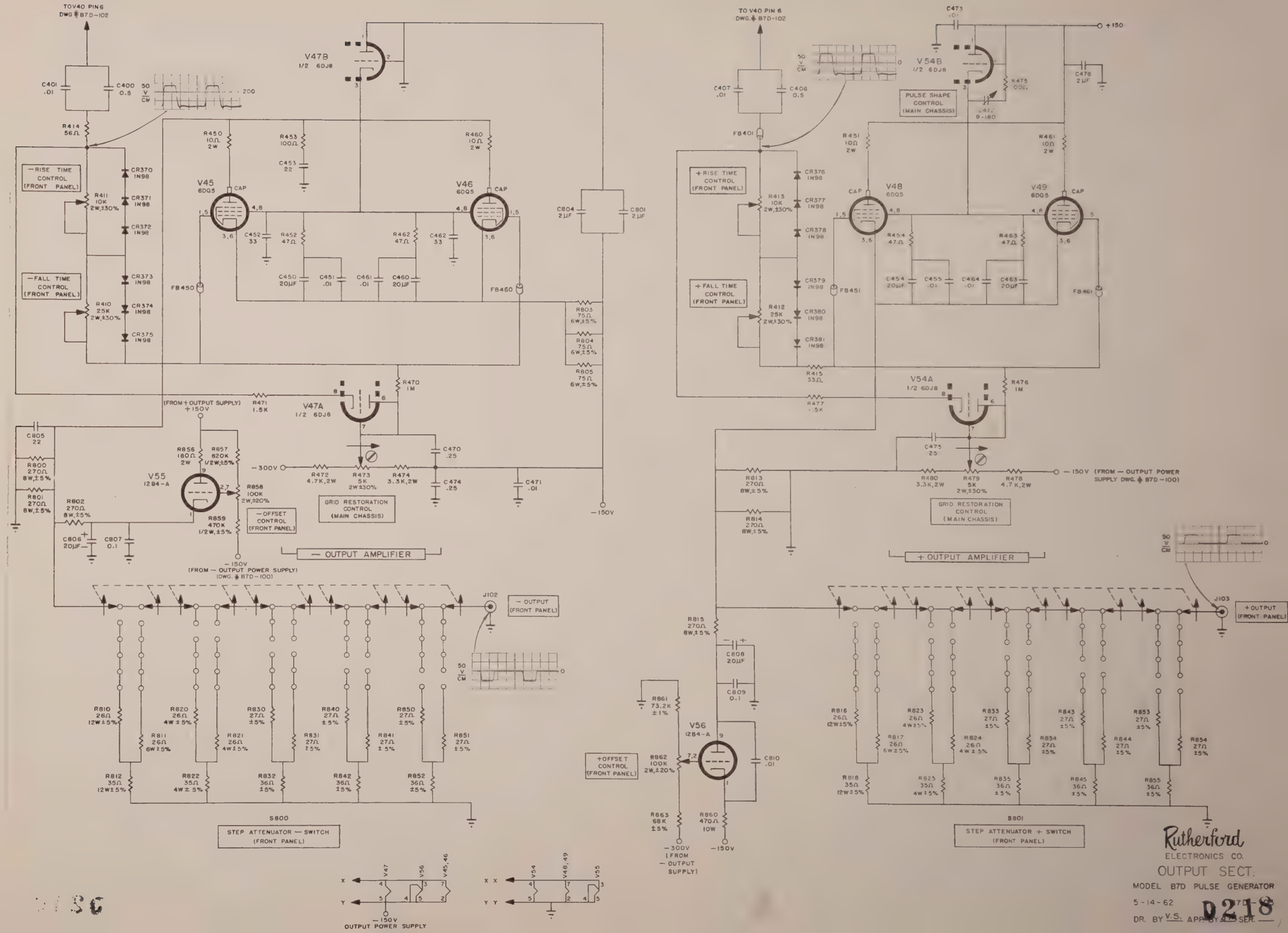
PULSE FORMING SECT.
MODEL B7D PULSE GENERATOR
2/16/62 B7D-102 A
DR. BY A.G. APP. BY JM SER.

NOTES: UNLESS OTHERWISE SPECIFIED,

1. ALL FIXED RESISTORS ARE 1/2 WATT, ±10%
2. ALL CAPACITOR VALUES ONE (1) OR LESS ARE IN MICROFARADS, THOSE GREATER THAN ONE (1) ARE IN MICROMICROFARADS.
3. STEP ATTENUATOR SWITCH, S800 & S801, SHOWN IN THE (0) DB. ATTENUATION POSITION.

WAVEFORMS

PULSE GENERATOR SETTING:	REP. RATE	2 MC
	DELAY	0.1 μSEC.
	WIDTH	0.15 μSEC.
OSCILLOSCOPE SETTING:	TIME/CM	0.1 μSEC.
(TEKTRONIX TYPE 541A)	VOLTS/CM	AS SPECIFIED



Rutherford ELECTRONICS CO.

OUTPUT SECT.

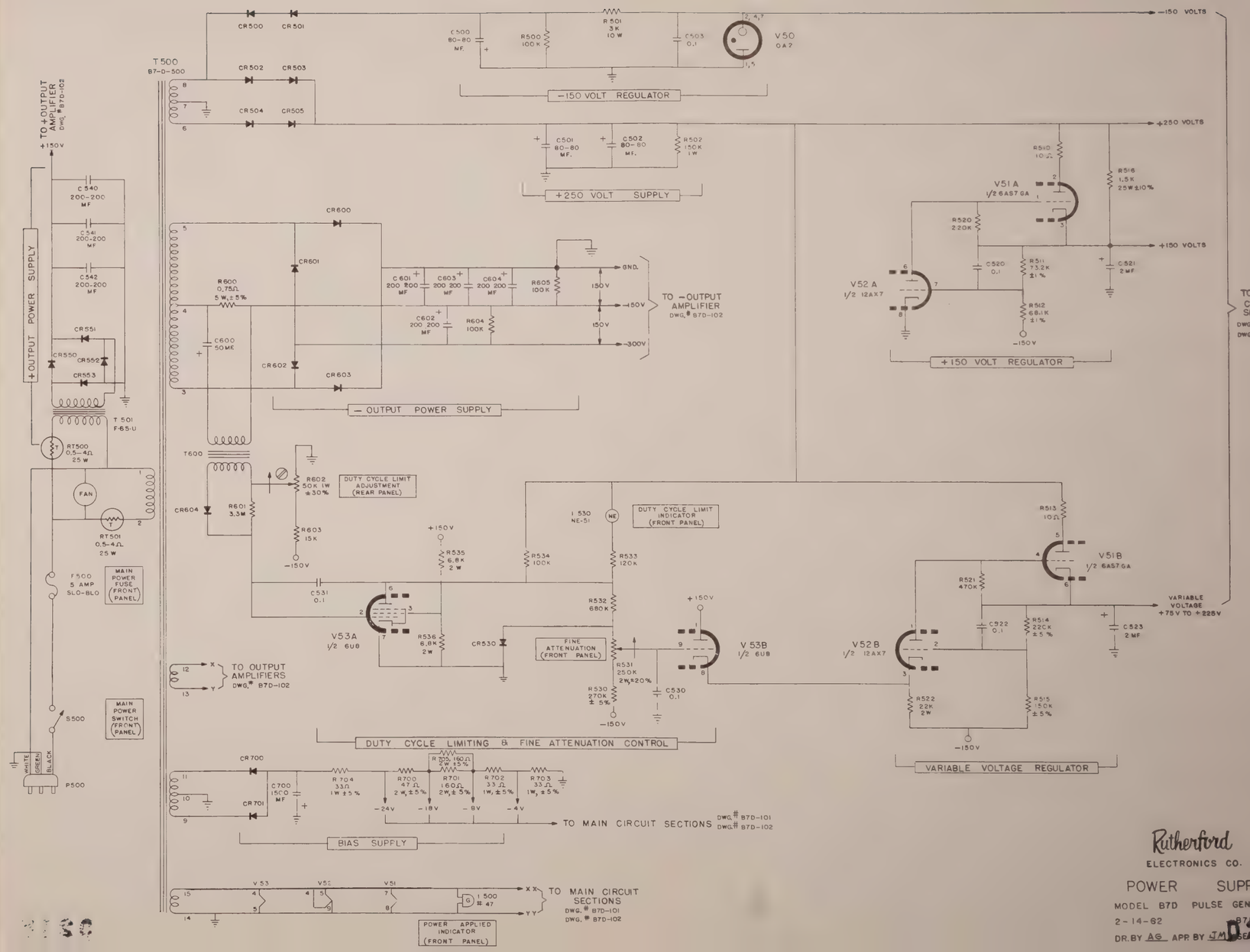
MODEL B7D PULSE GENERATOR

5-14-62 DR. BY V.S. APP. BY SER. D218

NOTES: UNLESS OTHERWISE SPECIFIED,

1 ALL FIXED RESISTORS ARE 1/2 WATT, ±10%

2 ALL CAPACITOR VALUES ONE (1) OR LESS ARE IN MICROFARADS, THOSE GREATER THAN ONE (1) ARE IN MICROMICROFARADS.



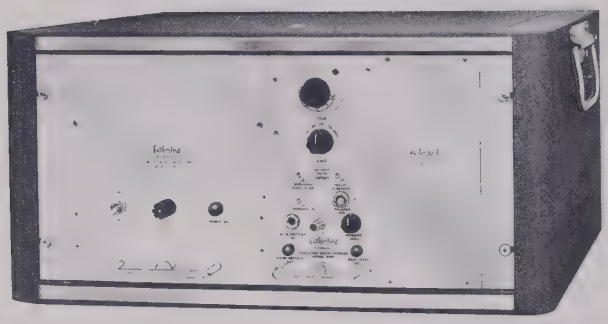
A	7 13 62	401	V.S.	DSL
CH. LTR.	DATE	C.O. NO.	BY	APP.

Rutherford
ELECTRONICS CO.

POWER SUPPLY
MODEL B7D PULSE GENERATOR
2-14-62 B7D-100
DR. BY AS APP. BY JM SE

0218

Rutherford



MODEL A9

A9-001

TIME DELAY SYSTEMS

The Rutherford Model A9 Time Delay Systems features all new transistorized circuitry, to make it the most reliable, highly accurate time delay generator available today.

Rutherford

A NEW CONCEPT IN PULSE AND TIME DELAY CIRCUITRY

The Model A9 Time Delay Systems and Model B9 Pulse Generating Systems represent a dynamic new approach to pulse and time delay circuitry. Choose from these groups of modules to fulfill all of your present and future pulse and time delay requirements.

wherever feasible.

REPETITION RATE MODULES

MODULE NO.	REP. RATE RANGE (KC/Sec.)	ACCURACY (% of F.S.)	JITTER (% of F.S.)	OUTPUTS (VOLTS, OPEN CIRCUIT)		POWER SUPPLY REQ'D	PRICE	REMARKS
				SYNC. PULSE	TRIG. OUT			
RR001	.001 - 100	±1	.05 max.	+10	−7	LVP001	$445	use 5-60V. pulse or 10-70V. sine wave for external trigger

DELAY MODULES

MODULE NO.	DELAY RANGE (μsec.)	ACCURACY (% of F.S.)	JITTER (% of F.S.)	TRIG. REQ'D (VOLTS)	OUTPUTS (VOLTS, OPEN CIRCUIT)				POWER SUPPLY REQ'D	PRIC
					#1	#2	GATE	RAMP		
D001	.8 - 100,000	.1 except 10 μsec. range	.006% or .01 μsec.	5-60 pulse 10-70 sine wave	+35	+12	+10	+3 to +12	LVP001	$51
D002	0 - 10,000	1 on 10 μsec. range .5 all other ranges (not specified below 1 μsec.)	.01% or .02 μsec.	−7	+20	−7	+10	+3 to +12	LVP001	$40

Printed circuitry is fea-
[illegible]

Hard tube circuitry is
[illegible]
high speed requirements
demand it.

WIDTH MODULES

All modules specified in the DELAY MODULE section are available as WIDTH MODULES. Simply replace the D in the part no. with a W.

Complete specifications on each Model are available on request.

PULSE FORMING MODULES

MODULE NO.	AMP. (VOLTS)	Zo (ohms)	tr (μsec.)	tf (μsec.)	ATTEN. (db)	POLARITY	POWER SUPPLY REQ'D	PRICE
PF001	50	50	.015	.015	60	+ or −	HVP001	$405

POWER SUPPLY MODULES

MODULE NO.	POWER REQUIRED	OUTPUTS (VOLTS/ma)	PRICE
LVP001	105-125 V.ac. 50-60 cps. 40 watts	+22.5/400, −22.5/400, +12/150 −12/150, +6/10, −3/10	$315
HVP001	105-125 V.ac. 50-60 cps. 375 watts	+250/90, +150/280, +var. +150 (float)/1.6 amp., −150 (float)/200 −150/5, −20/30, −18/35, 6.3 ac/8.5 amp. 6.3 ac (float)/6 amp.	$290

[illegible]
[illegible]
free service.

Let us know your present and future pulse and time delay requirements. They can be fulfilled to the letter with Model A9 or B9 systems.

SPECIFICATIONS:
MODEL A9-001

DELAY:

The Model A9-001 is a highly accurate time delay generator which exhibits the following characteristics:

RANGE: The output pulse may be delayed continuously from 0.8 to 100,000 microseconds (with respect to the input trigger) in five ranges:

0.8 microseconds to 10 microseconds
10 microseconds to 100 microseconds
100 microseconds to 1,000 microseconds
1,000 microseconds to 10,000 microseconds
10,000 microseconds to 100,000 microseconds

ACCURACY: The delay dial setting is accurate to the following tolerances, except for the 0.8 to 10 microseconds range for which no accuracy tolerance is specified:

After calibration: ± 0.1% of full scale.

JITTER: Time jitter introduced by the generator is less than 0.006% of full scale or 0.01 microseconds, whichever is greater.

DUTY FACTOR EFFECTS: Errors in delay may be introduced with increased duty factors. The table below indicates approximate error at various duty factors on the 100 to 1,000 microsecond range:

Duty Factor	Error	Duty Factor	Error
.02	Ref.	.75	3.6%
.05	1.01%	.90	5.1%
.20	0.6%	.95	6.4%
.50	2.2%		

Note: The duty factor must be limited to allow at least 3 microseconds recovery time.

LINE VOLTAGE VARIATION EFFECTS: A change of line voltage from 105 to 125 volts, RMS, changes the delay by 0.15%, maximum.

TEMPERATURE VARIATION EFFECTS: A change in ambient temperature will have the following effect on time delay:

0.8 to 10 microsecond range—a delay drift of 1% of full scale, maximum, over the range of 0°C. to +35°C.

All other ranges—a delay drift of 0.5% of full scale, maximum, over the range of −10°C. to +50°C.

MODULATION: Delay may be modulated by the introduction of an external voltage. A 2.8 to 12 volt change will vary the delay from minimum to maximum on any range.

OUTPUTS:

The following output wave forms are available at the front panel jacks.

BLOCKING OSCILLATOR OUTPUT: The blocking oscillator output occurs at the end of the time delay setting and exhibits the following characteristics:

Amplitude: 30 volts, peak, minimum
Rise Time: .030 microseconds, maximum
Width: .1 microseconds, minimum
Polarity: Positive.
Output Impedance: 50 ohms
Blocking Capacitor: .01 microfarad

MULTIVIBRATOR OUTPUT: A multivibrator output which occurs at the end of the time delay setting is provided for conveniently viewing the delay on an oscilloscope at slow sweep speeds. It exhibits the following characteristics:

Amplitude: 12 volts, peak, minimum Width:

Delay Range	Width
0.8 to 10 microseconds	Approx. 0.5 microsecond
100 microseconds	Approx. 5 microseconds
1,000 microseconds	Approx. 36 microseconds
10,000 microseconds	Approx. 120 microseconds
100,000 microseconds	Approx. 350 microseconds

Polarity: Positive
Output Impedance: 2K ohms
Blocking Capacitor: .01 microfarad

GATE OUTPUT: A gate output is provided which turns on with the input trigger and off at the end of the time delay. It exhibits the following characteristics:

Amplitude: 10 volts, peak, minimum
Polarity: Positive
Output Impedance: 100 ohms

RAMP OUTPUT: A ramp output is provided which starts with the trigger and turns off at the end of the time delay. It exhibits the following characteristics:

Amplitude: +3 to +12 volts
Polarity: Positive—going with delay.
Output Impedance: 470 ohms

INPUT TRIGGER:

The following trigger is required from an external source to initiate the time delay.

PULSE: The unit may be triggered by a pulse exhibiting the following characteristics:

Amplitude: 5 to 60 volts, peak
Width: 0.05 microseconds or greater
Polarity: Positive or Negative
Frequency: Single shot to 290KC
Note: Duty cycle limitation

SINE WAVE: The unit may also be triggered by a sine wave exhibiting the following characteristics;

Amplitude: 10-70 volts, peak to peak
Frequency: 5 cps to 290 KC

A trigger sensitivity control allows reliable triggering from an external source, regardless of waveform.

INPUT IMPEDANCE: 50K ohms, blocking capacitor for 100 volts

MISCELLANEOUS:

POWER REQUIRED: 105 to 125 volts, 0.35 amps., 50 to 60 cps., 40 watts
WEIGHT: Approx. 55 lbs.
DIMENSIONS: 10½" high x 22" wide x 15" deep
PRICE: $1,155.00 F.O.B. Culver City, California

All data subject to change without notice.

Bulletin A9-623-5M

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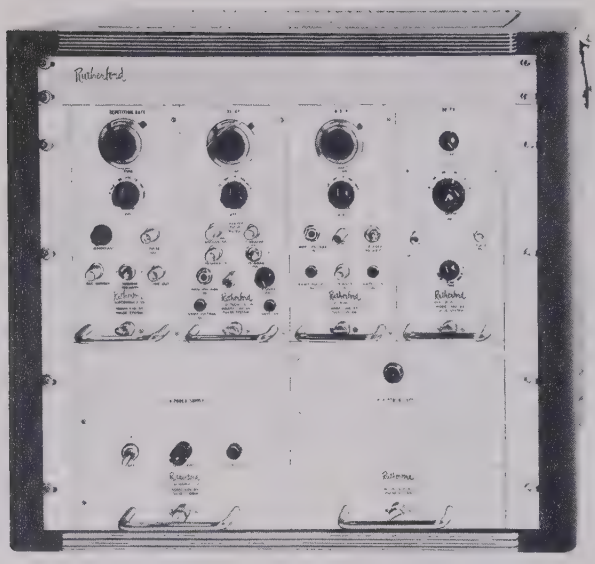

MODEL B9

B9-001

PULSE SYSTEMS

The Rutherford Model B9 Pulse Generating Systems is a precision pulse generator and features the plug-in module type construction to make it the finest, most reliable pulse generator available today.

Rutherford

A NEW CONCEPT IN PULSE AND TIME DELAY CIRCUITRY

The Model A9 Time Delay Systems and Model B9 Pulse Generating Systems represent a dynamic new approach to pulse and time delay circuitry. Choose from these groups of modules to fulfill all of your present and future pulse and time delay requirements.

New, solid state nonsaturated circuitry is featured wherever feasible.

REPETITION RATE MODULES

MODULE NO.	REP. RATE RANGE (KC/Sec.)	ACCURACY (% of F.S.)	JITTER (% of F.S.)	OUTPUTS (VOLTS, OPEN CIRCUIT)		POWER SUPPLY REQ'D	PRICE	REMARKS
				SYNC. PULSE	TRIG. OUT			
RR001	.001 - 100	±1	.05 max.	+10	−7	LVP001	$445	use 5-60V. pulse or 10-70V. sine wave for external trigger

DELAY MODULES

MODULE NO.	DELAY RANGE (μsec.)	ACCURACY (% of F.S.)	JITTER (% of F.S.)	TRIG. REQ'D (VOLTS)	OUTPUTS (VOLTS, OPEN CIRCUIT)				POWER SUPPLY REQ'D	PRICE
					#1	#2	GATE	RAMP		
D001	.8 - 100,000	.1 except 10μsec. range	.006% or .01 μsec.	5-60 pulse 10-70 sine wave	+35	+12	+10	+3 to +12	LVP001	$515
D002	0 - 10,000	1 on 10 μsec. range .5 all other ranges (not specified below 1 μsec.)	.01% or .02 μsec.	−7	+20	−7	+10	+3 to +12	LVP001	$405

WIDTH MODULES

Printed circuitry is fea-

All modules specified in the DELAY MODULE section are available as WIDTH MODULES. Simply replace the D in the part no. with a W.

Hard tube circuitry is
high speed requirements
demand it.

Complete specifications on each Model are available on request.

PULSE FORMING MODULES

MODULE NO.	AMP. (VOLTS)	Zo (ohms)	tr (μsec.)	tf (μsec.)	ATTEN. (db)	POLARITY	POWER SUPPLY REQ'D	PRICE
PF001	50	50	.015	.015	60	+ or −	HVP001	$405

POWER SUPPLY MODULES

MODULE NO.	POWER REQUIRED	OUTPUTS (VOLTS/ma)	PRICE
LVP001	105-125 V.ac. 50-60 cps. 40 watts	+22.5/400, −22.5/400, +12/150 −12/150, +6/10, −3/10	$315
HVP001	105-125 V.ac. 50-60 cps. 375 watts	+250/90, +150/280, +var. +150 (float)/1.6 amp., −150 (float)/200 −150/5, −20/30, −18/35, 6.3 ac/8.5 amp. 6.3 ac (float)/6 amp.	$290

free service.

Let us know your present and future pulse and time delay requirements. They can be fulfilled to the letter with Model A9 or B9 systems.

SPECIFICATIONS / MODEL B9-001

REPETITION RATE

RANGE: The internal oscillator is continuously variable from 1 cycle per sec. to 100 kilocycles, in 5 ranges.

1 cps — 10 cps	1 kc — 10 kc
10 cps — 100 cps	10 kc — 100 kc
100 cps — 1kc	

DIAL CALIBRATION: 1,000 divisions per range.

ACCURACY: The repetition rate dial setting is accurate to the following tolerance:
After Calibration: ±1% of full scale.

JITTER: Pulse to pulse jitter introduced by the generator is approx. 0.05% of full scale.

LINE VOLTAGE VARIATION EFFECTS: A change of line voltage from 105 to 125 V, RMS, changes the frequency by 0.13%.

TEMPERATURE VARIATION EFFECTS: A change in ambient temperature will have the following effect on the frequency: A frequency drift of 1% of full scale, max., over the range of 0°C to +50°C on all ranges.

MODULATION: Frequency may be modulated by the introduction of an external voltage. A change of approx. +1.1 to +3.4 V. will vary the frequency from 0.1 to full scale on all ranges.

SINGLE PULSE: A micro switch provides a single pulse at each of the outputs.

EXTERNAL TRIGGER INPUT:

Pulse: The unit may be triggered by a pulse exhibiting the following characteristics:
Amplitude: 5 to 60 V., peak.
Width: 0.05 usec. or greater
Minimum Rate of Rise: 120 V/sec
Polarity: Positive or negative
Frequency: Single shot to 290 kc

Sine Wave: The unit may also be triggered by a sine wave exhibiting the following characteristics:
Amplitude: 10 - 70 V, peak to peak
Frequency: 5 cps to 290 kc

Input Impedance: 50K ohms, blocking capacitor for 100 V.

SYNC PULSE OUT: Blocking oscillator output pulse through an emitter follower is delayed from the rep. rate trigger pulse by approx. 2 usec. and exhibits the following characteristics:
Amplitude: 10 V, min., open circuit
Polarity: Positive
Rise Time: 0.05 usec.
Width: 0.2 usec.
Output Impedance: 390Ω
Blocking Capacitor: 0.01 ufd., 500V

WIDTH

RANGE: The main pulse width is continuously variable from 0.05 usec. to 10,000 usec. in 5 ranges:

0.05 usec. — 1 usec.	100 usec. — 1,000 usec.
1 usec. — 10 usec.	1,000 usec. — 10,000 usec.
10 usec. — 100 usec.	

DIAL CALIBRATION: 1,000 divisions per range.

ACCURACY: The width dial setting is accurate to the following tolerances, except for the 0.05 usec. to 1 usec. range for which no accuracy tolerance is specified:
After Calibration:
1 - 10 usec. range: ±1% of full scale
All other ranges: ±0.5% of full scale

JITTER: Time jitter introduced by the width module is less than 0.01% of full scale or 0.02 usec., whichever is greater.

LINE VOLTAGE VARIATION EFFECTS: A change of line voltage from 105 to 125 V, RMS, changes the pulse width by 0.15%, max.

TEMPERATURE VARIATION EFFECTS: A change in ambient temp. will have the following effects on the pulse width, except on the 0.05 - 1 usec. range for which no temp. variation effect is specified.
1 - 10 usec. range: a pulse width drift of 1% of full scale, max., over the range of 0 C to +35 C
All other ranges: a pulse width drift of 0.5% of full scale, max., over the range of 10 C to +50 C

MODULATION: Pulse width may be modulated by the introduction of an external voltage. A change from approx. +2.8 to +12 V. will vary the pulse width from min. to max. on any range.

GATE OUTPUT: A gate output is provided which turns on at the end of the delay and turns off at the end of the pulse width. It exhibits the following characteristics:
Amplitude: 10 V, peak, min., open circuit
Polarity: Positive Output Impedance: 100Ω

RAMP OUTPUT: A ramp output is provided which starts at the end of the delay and turns off at the end of the pulse width. It exhibits the following characteristics:
Amplitude: +3 to +12 V, at maximum width of range, open circuit
Polarity: Positive—going with width Output Impedance: 470Ω

DELAY

RANGE: The main pulse delay is continuously variable, with respect to the sync pulse out, from 0.0 usec. to 10,000 usec., in 5 ranges:

0 — 1 usec.	100 usec. — 1,000 usec.
1 usec. — 10 usec.	1,000 usec. — 10,000 usec.
10 usec. — 100 usec.	

DIAL CALIBRATION: 1,000 divisions per range.

ACCURACY: The delay dial setting is accurate to the following tolerance, except for the 0.0 usec. to 1 usec. range for which no accuracy tolerance is specified:
After Calibration:
1-10 usec. range: ±1% of full scale
All other ranges: ±0.5% of full scale

JITTER: Time jitter introduced by the delay module is less than 0.01% of full scale or 0.02 usec., whichever is greater.

DUTY FACTOR EFFECTS: Errors in delay may be introduced with increased duty factors. Table below indicates approx. error at various duty factors on the 100 to 1,000 usec. range.

DUTY FACTOR	ERROR	DUTY FACTOR	ERROR
.02	Ref.	.75	3.6%
.05	0.01%	.90	5.1%
.20	0.6%	.95	6.4%
.50	2.2%		

Note: Duty factor must be limited to allow at least 3 usecs. recovery time.

LINE VOLTAGE VARIATION EFFECTS: A change of line voltage from 105 to 125 V, RMS, changes the delay by 0.15%, max.

TEMPERATURE VARIATION EFFECTS: A change in ambient temp. will have the following effect on the delay, except for the 0.0 - 1 usec. range for which no temp. variation effect is specified:
1 - 10 usec. range: a delay drift of 1% of full scale, max., over the range of 0°C to +35°C
All other ranges: a delay drift of 1% of full scale, max., over the range of 10°C to +50°C

MODULATION: Delay may be modulated by the introduction of an external voltage. A change from approx. +2.8 to +12 V will vary the delay from min. to max. on any range.

GATE OUTPUT: A gate output is provided which turns on with the rep. rate trigger pulse and off at the end of the delay. It exhibits the following characteristics:
Amplitude: 10 V, peak, min., open circuit
Polarity: Positive Output Impedance: 100Ω

RAMP OUTPUT: A ramp output is provided which starts with the rep. rate trigger pulse and stops at the end of the delay. It exhibits the following characteristics:
Amplitude: +3 to +12 V, at max. delay of range, open circuit
Polarity: Positive—going with delay Output Impedance: 470Ω

MAIN PULSE OUTPUT

AMPLITUDE: 50 V, minimum, into a 50Ω load.

POLARITY: Positive or negative, but not simultaneously.

RISE TIME: 0.015 usec., or less.

FALL TIME: 0.015 usec., or less.
NOTE: Both rise and fall time may be degraded simultaneously to approx. 1 usec.

STEP ATTENUATOR: 5 steps of 10db attenuation.

FINE ATTENUATION CONTROL: 10db variable attenuation through any 10db step.

OVERSHOOT AND UNDERSHOOT: 5% max., except when pulse is attenuated more than 30db with the 10db step attenuator; 30%, max., at 50db down.

DROOP: 0.05 - 100 usec. wide pulse — Negligible.
100 - 1,000 usec. wide pulse — 15%, max.
1,000 - 10,000 usec. wide pulse — 25%, max.

DUTY FACTOR: 30% at full amplitude.

OUTPUT IMPEDANCE: 50Ω

MISCELLANEOUS SPECIFICATIONS

POWER REQUIRED: 105-125 V, 3.25 amps, 50-60 cps, 340 watts.

VENTILATION: Filtered, forced air.

DIMENSIONS: 19" H x 22" W x 18" D.

WEIGHT: 100 lbs., net.

ACCESSORIES INCLUDED: One instruction manual.

PRICE: $1,975 f.o.b. Culver City, California.

Representatives and Service in the major cities of the World

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pulse generators, pulse systems, accurate time delay generators

A highly versatile, precision, general purpose instrument designed to meet the rigid standards of research and development from biological research at low repetition rates, to transistors, transistor circuits, and magnetic core research at high repetition rates.

MODEL **B-7B**

Rutherford PULSE GENERATOR

DESIGNED FOR...

HIGH PERFORMANCE AND LONGER LIFE AT LOW COST

featuring...

EASE OF MAINTENANCE AND OPERATION

- PRINTED CIRCUIT BOARDS with all components clearly identified by schematic symbol numbers.
- A NEW STABILIZED NOISE-FREE REPETITION RATE SECTION.
- VARIABLE RISE TIME CONTROL.
- A NEW SINGLE UNIT CONSTRUCTION for years of trouble-free operation.
- RACK MOUNTABLE.
- FEW TUBES MEAN FEW REPAIRS.
- PROTECTED AGAINST OVER-LOAD.
- COMPLETE COVERAGE:

Rep Rate	Delay	Width
High to Low	Short to Long	Narrow to Wide

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SPECIFICATIONS . . . . MODEL B-7B

REPETITION RATE:	20 c/s to 2 mc/s, continuously variable in five ranges.
EXTERNAL TRIGGER:	Unit may also be triggered from an external source by a pos. or neg., 20 volt pulse at rep. rates to 2 mc/s.
	Note: The fast rise time quality of the B7B sync. pulse allows the triggering of one or more B7Bs from the sync. pulse of a master unit at all rep. rates.
DELAY:	0.0 μ sec. to 10,000 μ sec., continuously variable in five ranges. (Referenced to the sync. pulse.)
WIDTH:	0.05 μ sec. to 10,000 μ sec., continuously variable in five ranges. (Measured at the 50% amplitude points.)
AMPLITUDE:	50 volts, minimum, into 50 ohms.
DUTY FACTOR:	30%, maximum, at full output amplitude. Automatic limiting circuitry reduces the output amplitude at duty factors greater than 30%. Unit may be safely operated to approx. a 70% duty factor. Output amplitude is approx. 35 volts at 50% duty factor and approx. 20 volts at 70%.
ATTENUATION:	0 to 60 db. down, continuously variable.
RISE TIME:	0.015 μ sec., or less.
FALL TIME:	0.015 μ sec., or less.
	Note: Rise and fall time may be simultaneously degraded to approx. 1 μ sec. by front panel control.
POLARITY:	Positive or negative, but not simultaneously.
OVERSHOOT & UNDERSHOOT:	5%, maximum, at full amplitude.
DROOP:	0-100 μ sec. wide pulse — negligible. 100-1,000 μ sec. wide pulse — 15%, max. 1,000-10,000 μ sec. wide pulse — 25%, max.
SYNC. PULSE OUT:	Amplitude — .10 volts, min. Width — 0.05 μ sec., min. Rise time — 0.03 μ sec., max. Polarity — Positive.
SIZE:	19" wide, 8¾" high, 13" deep.
WEIGHT:	Approx. 42 lbs., net 53 lbs., shipping wt.
POWER REQ'D:	115 volts, 3.26 amps., 50-60 c/s, 375 watts.
PRICE:	$720.00, F.O.B. Culver City, California.

All data subject to change without notice.

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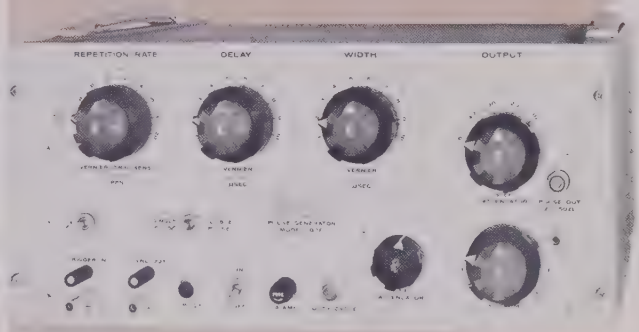
pulse generators / pulse systems / accurate time delay generators

Rutherford MODEL B-7F

DOUBLE PULSE GENERATOR

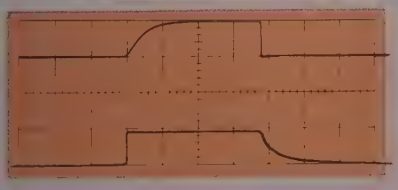
The NEW MODEL B-7F incorporates all of the time-proven specifications of the popular MODEL B-7B . . .



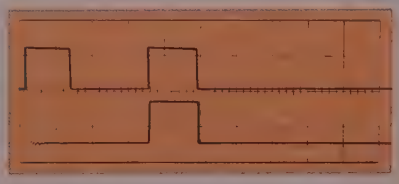
PLUS THREE NEW FEATURES

- **2 cycle/second Repetition Rate**
  Repetition rate is continuously variable from 2 cycles/second to 2 megacycles/second.
- **Separate and Independent Rise and Fall Time Controls**
  The rise or fall time of the output pulse may be independently degraded to approximately 1 μ sec.
- **Double Pulse Output**
  Either single or double pulse output available by front panel control.

Double exposure photograph showing independent degradation of (a) rise time and (b) fall time.



Double exposure photograph showing (a) double pulse output and (b) single pulse output.



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SPECIFICATIONS . . . . MODEL B-7F

REPETITION RATE: 2 c/s to 2 mc/s, continuously variable in six ranges.

EXTERNAL TRIGGER: Unit may also be triggered from an external source by a pos. or neg., 20 volt pulse at rep. rates to 2 mc/s.

Note: The fast rise time quality of the B-7F sync. pulse allows the triggering of one or more B-7F's from the sync. pulse of a master unit at all rep. rates.

DELAY: 0.0 μ sec. to 10,000 μ sec., continuously variable in five ranges. (Referenced to the sync. pulse.)

Note: In the double pulse mode, the first pulse is fixed at approximately zero delay. The second pulse is delayable from 0.5 to 10,000 u sec. with respect to the leading edge of the first pulse.

WIDTH: 0.05 μ sec. to 10,000 μ sec., continuously variable in five ranges. (Measured at the 50% amplitude points.)

Note: In the double pulse mode, both output pulses are controlled simultaneously in width.

AMPLITUDE: 50 volts, minimum, into 50 ohms. (both single and double pulse)

DUTY FACTOR: 30%, maximum, at full output amplitude. Automatic limiting circuitry reduces the output amplitude at duty factors greater than 30%. Unit may be safely operated to approx. a 70% duty factor. Output amplitude is approx. 35 volts at 50% duty factor and approx. 20 volts at 70%. In the double pulse mode, duty-factor applies to the sum of both pulse widths.

ATTENUATION: 0 to 60 db. down, continuously variable.

RISE TIME: 0.015 μ sec., or less.

FALL TIME: 0.015 μ sec., or less.

Note: Rise and fall time of the output pulse may be independently degraded to approx. 1 μ sec. In the double pulse mode, rise times degrade simultaneously and fall times degrade simultaneously.

POLARITY: Positive or negative, but not simultaneously.

OVERSHOOT & UNDERSHOOT: 5%, maximum, at full amplitude.

DROOP: 0-100 μ sec. wide pulse — negligible.
100-1,000 μ sec. wide pulse — 15%, max.
1,000-10,000 μ sec. wide pulse — 25%, max.

SYNC. PULSE OUT: Amplitude — 10 volts, min.
Width — 0.05 μ sec., min.
Rise time — 0.03 μ sec., max.
Polarity — Positive.

SIZE: 19" wide, 8¾" high, 13" deep.

WEIGHT: Approx. 42 lbs., net
53 lbs., shipping wt.

POWER REQ'D: 115 volts, 3.26 amps., 50-60 c/s, 375 watts.

PRICE: $920.00 F.O.B. Culver City, California.

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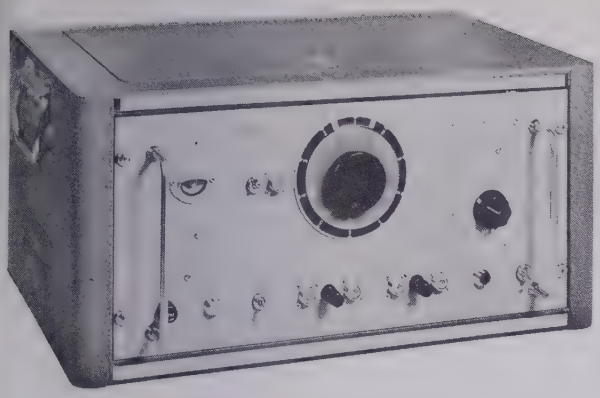
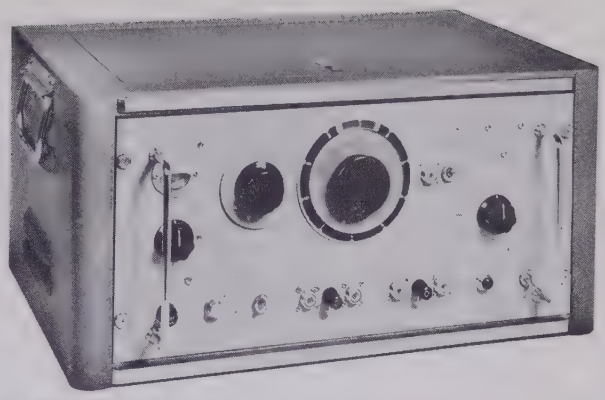


MODEL A-2



MODEL A-4

TIME DELAY GENERATORS

PLICATIONS OF RUTHERFORD MODEL A-2 DELAY GENERATOR

alibration of synchroscopes... measurement of radar range... mulation of radar range... simulation of moving targets (with uxiliary equipment)... delaying synchroscope sweeps... produc- on of accurately spaced pulses for biological investigations... easurement of waveform timing... measurement of time delays . measurement of pulse width... to replace internal delay cir- uits of pulse generators when a more accurate delay is required . testing the resolving time of counters (with auxiliary equipment) . measurement of sonar range

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CULVER CITY, CALIFORNIA

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TWX-CVR-CY 4133

SPECIFICATIONS

MODEL A-2

DELAY RANGES:

.8 to 100,000 microseconds. In five decade ranges

INCREMENTAL DELAY:

Limited by the resolution of the helical potentiometer control to 1/9800 of full scale.

JITTER:

.01 microsecond or .008%, whichever is greater.

ACCURACY:

After calibration: ±.1% of full scale.

Long term: ±1% of full scale.

LINEARITY:

.3% or better between .1 full scale and full scale (except on .8 to 10 microsecond range).

INPUT:

Amplitude:

15 volts min., 60 volts max. pulse.

30 volts RMS 100 cycle sine wave min., 60 volts max.

Blocking Condenser:

for 400 volts.

Impedance:

20 mmfd and 470,000 ohms.

DIAL CALIBRATION:

1000 divisions, each approximately ⅛ inch wide.

DATA SUBJECT TO CHANGE WITHOUT NOTICE.

on No. 11

OUTPUT PULSES:

BLOCKING OSCILLATOR

Width: .5 microsecond wide between 10% points, approx.

Rise Time: .1 microsecond between 10% and 90% points.

Output Impedance: 100 ohms (.01 mfd blocking condenser).

Amplitude: 50 volts, open-circuited.

MULTIVIBRATOR

Widths approximately as per table below. For presentation on synchroscope.

Range	Width
10 microseconds	5 microseconds
100 microseconds	10 microseconds
1,000 microseconds	30 microseconds
10,000 microseconds	100 microseconds
100,000 microseconds	400 microseconds

Output Impedance: 500 ohms (.1 mfd blocking condenser).

Amplitude: 35 volts, open-circuited.

EXTERNAL DELAY VOLTAGE:

150 to 50 volts . . . zero to full delay.

REPETITION RATE EFFECTS:

The error introduced by repetition rate changes is a function of the percent duty factor. A representative table of duty factor effects for 1,000 microsecond scale is shown below:

Duty Factor	Error
.5%	0 (reference)
5%	.1%
50%	.4%
90%	3.2%
95%	5%
97%	5.5%

The duty factor must be limited to allow at least 3 microseconds recovery time.

EFFECT OF LINE VOLTAGE VARIATIONS:

Variations from 105 volts to 125 volts changes the delay by .15%.

INDICATING LAMPS:

Pilot light (on-off): Blown fuse.

INDICATOR TUBE:

"Magic Eye" tube type 6E5 to indicate coincidence of delayed pulse and calibrating pulse.

POWER:

105-125 volts, 50-60 cycles, 140 watts.

SIZE:

Mounts on standard 8¾"x 19" relay rack panel. Chassis is 13" deep. With dust cover is 10½" high, 22¼" wide and 14⅞" deep overall, including front panel protective handles.

WEIGHT: 53 pounds

ACCESSORIES SUPPLIED: Instruction book

PRICE: $750.00 F.O.B. Culver City.

SPECIFICATIONS

MODEL A-4

Basically the same as Model A-2 except as follows:

DELAY RANGES:

.00001 to 10 seconds. In five decade ranges

INTERNAL OSCILLATOR:

RANGES:

1,000 cps to 100 cps
100 cps to 10 cps
10 cps to 1 cps
1 cps to .1 cps

MULTIVIBRATOR

Widths approximately as per table below. For presentation on synchroscope.

Range	Width
.001 second	30 microseconds
.01 second	100 microseconds
.1 second	500 microseconds
1. second	5,000 microseconds
10. second	50,000 microseconds

Output Impedance: 500 ohms (1 mfd blocking condenser).

Amplitude: 35 volts.

TRIGGER

Same as blocking oscillator.

PRICE:

$875.00 F.O.B. Culver City.

Other Rutherford instruments you might find useful in your laboratory:

1. High Repetition Rate Pulse Generators
2. Precision Time Delay Generators
3. General Purpose Pulse Generators
4. Versatile Modular Construction Pulse Generators
5. Special Design Pulse Instrumentation
6. 10 Megacycle Pulse Generators
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8. Variable Rise Time Generators
9. Low Jitter Pulse Generators
10. Multiple Pulse and Pulse Code Generators
11. Pulse Systems

Rutherford

PULSE GENERATOR / MODEL B5-A

Precision
PULSE FORMING
and TIMING
INSTRUMENTS

EATURING:

High Repetition Rate with no greater than 8 Millimicroseconds Rise and Fall Time operating from 1 cps to 10 megacycles.

The Model B5-A, built to the most exacting standards of precision engineering, offers an unparalleled combination of good, clean pulses and high repetition rate and fast rise and fall times. The unit provides an electronic pulse delay that can be set to zero or is continuously variable from .030 microseconds to 500 microseconds in five ranges. Pulse width is continuously variable from .02 to 12.5 microseconds in four ranges.

Rutherford ELECTRONICS CO.

8944 Lindblade Street, Culver City, Calif. • Telephone: UPton 0-7393
TWX-CVR-CY-4133

SPECIFICATIONS B-5A

MAIN PULSE: PULSE WIDTH: continuously variable from .02 microsecond to 12.5 microseconds (duty factor limited to 20%) in four ranges:

.02 to .1 microsecond
.1 to .5 microsecond
.5 to 2.5 microseconds
2.5 to 12.5 microseconds

AMPLITUDE: 40 volts positive, 45 volts negative.

ATTENUATOR: 60 db in ½ db steps.

RISE AND FALL TIME: no greater than 8 millimicroseconds.

POLARITY: both positive and negative pulses simultaneously available.

OUTPUT IMPEDANCE: 185 ohms (the instrument must be terminated for proper pulse shape).

PERCENT DROOP: no greater than 6%.

SYNCHRONIZING PULSE OUT: 10 volts, positive.

RISE TIME: less than .02 microsecond.

WIDTH: .03 microsecond.

EXERNAL TRIGGER: Pulse Required: 10 volts minimum with rise time less than .05 microsecond.

PULSE REPETITION RATE: Continuously variable from 1 cycle/sec to 10 mc/sec in seven ranges:

1 c to 10 c
10 c to 100 c
100 c to 1 kc
1 kc to 100 kc
10 kc to 100 kc
100 kc to 1 mc
1 mc to 10 mc

DELAY: A fixed delay of .1 microsecond occurs between the synchronizing pulse out and the main pulse.

ELECTRONIC PULSE DELAY: can be set to zero or is continuously variable from 0.030 μsec. to 500 μsecs in 5 ranges.

Note: Pulse delay is limited to approximately 20% of the pulse spacing.

POWER REQUIRED: 105-125 volts, 50-60 cycles, 600 watts.

CONNECTORS:

Sync. Pulse Out—type BNC.
External Trigger—type BNC.
Main Pulse—type C.

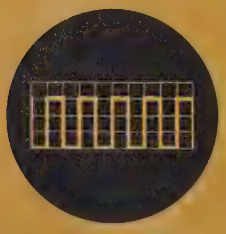
DIMENSIONS: 23" high, 23" wide, 16" deep.

WEIGHT: 110 pounds.

ACCESSORIES SUPPLIED

1 unit extension cable.
1 5-ft. output cable (type RG 114/U)
1 185 ohm non-inductive resistor.
1 185 ohm termination assembly.
1 instruction manual.

PRICE: $2,400.00 F.O.B. Culver City, California.



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pulse generators / pulse systems / accurate time delay generators

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APL 860

ACCESSORY ASSEMBLIES

PRINTED IN U.S.A.
AUGUST 1, 1960

Rutherford accessories are precisely designed to enhance greater efficiency and performance, ease of operation for use in pulse instrumentation

PART NO.	DASH NO.	NAME	DESCRIPTION	PRICE
J001	–1	Extension Cable, Coax. 185 ohms (RG 114/u) Type C Connector, Both Ends	6 in. long	$17.50
	–2		10 in. long	17.50
	–3		20 in. long	17.50
	–4		24 in. long	17.50
	–5		48 in. long	19.50
	–6		96 in. long	19.50
J002	–1	Extension Cable, Coax. 185 ohms (RG 114/u) Type C Connector, One end, Open Other End	24 in. long	10.00
	–2		48 in. long	10.00
	–3		60 in. long	10.50
	–4		96 in. long	10.50
J003	–1	Extension Cable, Coax. 50 ohms (RG 58/u) Type BNC Connector, Both Ends	12 in. long	5.00
	–2		24 in. long	5.00
	–3		48 in. long	5.50
	–4		96 in. long	5.50
J004	–1	Extension Cable, Coax. 50 ohms (RG 58/u) Type BNC Connector, One End, Open Other End	12 in. long	2.50
	–2		24 in. long	2.50
	–3		48 in. long	3.50
	–4		96 in. long	3.50
J005	–1	Extension Cable, Coax. 50 ohms (RG 58/u) Type N Connector, Both Ends	24 in. long	9.50
	–2		48 in. long	10.00
	–3		96 in. long	10.00
J006	–1	Extension Cable, Coax. 50 ohms (RG 58/u) Type N Connector, One End, Open Other End	24 in. long	5.00
	–2		48 in. long	5.50
	–3		96 in. long	5.50
J007	–1	Extension Cable, Coax. 50 ohms (RG 58/u) Type UHF Connector, Both Ends	12 in. long	4.50
	–2		24 in. long	4.50
	–3		48 in. long	5.00
	–4		96 in. long	5.00
J008	–1	Extension Cable, Coax. 50 ohms (RG 58/u) Type UHF Connector, One End, Open Other End	12 in. long	2.50
	–2		24 in. long	2.50
	–3		48 in. long	3.00
	–4		96 in. long	3.00
J009	–1	Extension Cable, Coax. 93 ohms (RG 62/u) Type BNC Connector, Both Ends	12 in. long	9.00
	–2		24 in. long	9.00
	–3		48 in. long	9.50
	–4		96 in. long	9.50
J010	–1	Extension Cable, Coax. 93 ohms (RG 62/u) Type BNC Connector, One End, Open Other End	12 in. long	4.50
	–2		24 in. long	4.50
	–3		48 in. long	5.50
	–4		96 in. long	5.50

PART NO.	DASH NO.	NAME	DESCRIPTION	PRICE
J011	–1	Extension Cable, Coax. 93 ohms (RG 62/u) Type UHF Connector, Both Ends	12 in. long	4.50
	–2		24 in. long	4.50
	–3		48 in. long	5.50
	–4		96 in. long	5.50
J012	–1	Extension Cable, Coax. 93 ohms (RG 62/u) Type UHF Connector, One End, Open Other End	12 in. long	2.50
	–2		24 in. long	2.50
	–3		48 in. long	3.50
	–4		96 in. long	3.50
J014		Extension Cable, 16 Wire, Amphenol 26-4100-16P Plug, One End, 26-4200-16S Socket, Other End	40 in long. Extension Cable to be used with Model B3 and Model B5 Systems	15.00
J015		Extension Cable, 11 wire, Amphenol #86 PM11 Plug, One End, #78 PF11 Socket, Other End	24 in. long. Extension Cable to be used with Model B2 and B2A Pulse Generators	9.00
J017	–1	Adapter	Adapter, Banana Plug to Type I BNC Coax. Connector, Non-Locking	6.50
	–2	Adapter	Adapter, Banana Plug to Type BNC Coax. Connector, Lock-on Type	7.50
	–3	Adapter	Adapter, Banana Plug to Type UHF Coax. Connector, Lock-on Type	7.50
	–4	BNC Binding Post Adapter	Can be used to adapt the Single Shot Pulse Generator to the B-5A 10 MC Pulse Generator.	7.50
J018		"One-Shot" Pulse Generator	"One-Shot" Push Button Actuated Pulse Generator. Suitable for Single Pulse Operation of Model B7 Pulse Generator. 18 Volt Pulse into 470 ohms Mounts in Standard Banana Jacks	47.50
J019	–1	Air Filter End Cover	Replaces Intake End Cover on Model B7 Pulse Generator to Prevent Excessive Dust from Entering Instrument. Filter Removable for Cleaning or Replacement	18.00
	–2	Air Filter End Cover	Same as –1, Except for Model B7B Pulse Generator	18.00
J013		Mixer Assembly	"Two Input" Mixer Assembly for B3 System	55.00
J032	–1	Mixer Assembly	"Two Input" Mixer Assembly for Model B7 or B7B. Maximum Input Power Each, Input 30 Watts Average. Impedance 50 ohms	45.00
	–2	Mixer Assembly	"Three Input" Mixer Assembly for Model B7 or B7B. Maximum Input Power Each, Input 30 Watts Average. Impedance 50 ohms	60.00
	–3	Mixer Assembly	"Four Input" Mixer Assembly for Model B7 or B7B. Maximum Input Power Each, Input 30 Watts Average. Impedance 50 ohms	75.00

INSTRUCTION MANUALS

NOTE: Serial Numbers of Instrument Must Be Included When Reordering Instruction Manuals

PART NO.	DASH NO.	NAME	DESCRIPTION	PRICE
J020		Instruction Manual	For Model A2 or Model A4 Time Delay Generator	5.00
J021	–1*	Instruction Manual	For Model B2 Pulse Generator	7.50
	–2		For Model B2A Pulse Generator	7.50
J022*	–1	Instruction Manual	For Model B3 Pulse Generator	7.50
	–2		For Model B3-2 Pulse Generator	10.00
	–3		For Model B3-2A Pulse Generator	10.00
	–4		For Model B3-3 Pulse Generator	10.00
	–5		For Model B3-4 Pulse Generator	10.00
J023*		Instruction Manual	For Model B4 Time Measuring System	7.50
J024	–1*	Instruction Manual	For Model B5 Pulse Generator	7.50
	–2		For Model B5A Pulse Generator	7.50
	–3		For Model B5-2 Pulse Generator	10.00
J025	–1*	Instruction Manual	For Model B7 Pulse Generator	5.00
	–2		For Model B7B Pulse Generator	5.00
J026*		Instruction Manual	For Model D2 Calibrator	7.50
J027*		Instruction Manual	For Model G1 Pulse and Sq. Wave Generator	7.50
J028		Instruction Manual	For Model J018 "One-Shot" Pulse Generator	3.00

*Indicates Instrument No Longer In Production, But Manuals For Existing Instruments Available

INSTRUMENT MODIFICATION

PART NO.	DASH NO.	NAME	DESCRIPTION	PRICE
J029	–1		Modifies the Model B2A to Provide for External Delay and Width Modulation	115.00
	–2		Modifies the Model B2A to Provide for External Delay Modulation	65.00
J030			Modifies Model B2 to Configuration and Specification of the Model B2A	400.00
J031			Modifies Model A2 or Model A4 to Incorporate Special Delay Range Per Customer Requirement	60.00
J033			Modifies Model B5 to Model B5-A	1,000.00
J034			Modifies Model B5 to Model B5-2 Double Pulse Generator	3,073.00
J035			Modifies Model B5-A to Model B5-2 Double Pulse Generator	2,080.00
J036			Delay Cable Model B5-2	325.00

THE ACCESSORIES ARE DESIGNED TO COMPLEMENT *Rutherford* PULSE INSTRUMENTATION

NEW MODEL B7-B HIGH REPETITION RATE PULSE GENERATOR AT LOW COST, HIGH PERFORMANCE and WIDE VERSATILITY

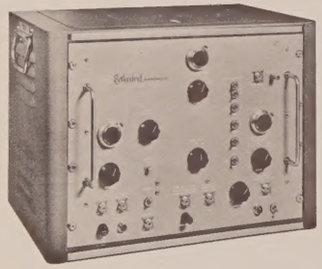
50 volts into 50 ohms at 30% duty factor . . . rep. rate to 2 mc . . . widths .05 μs to 10,000 μs . . . delays to 10,000 μs . . .

Low Budget Price . . . **$720.00**

10 MEGACYCLE PULSE GENERATOR MODEL B5-A

Featuring . . . high repetition rate with no greater than 8 millimicroseconds rise and fall time operating from 1 cps to 10 megacycles.

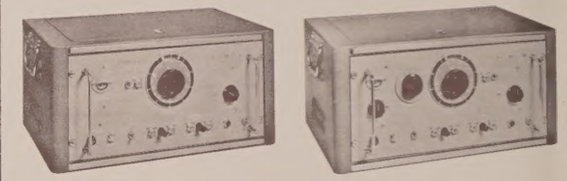
Price: **$2,400.00**



MODEL B2-A

A general purpose instrument which produces pulses of accurately controlled widths, amplitude and time delay at low impedance. Internal oscillator gives repetition rates from 10 cycles to 100 kc. Pulse widths from .08 μs to 1,000 μs.

Price: **$1,280.00**

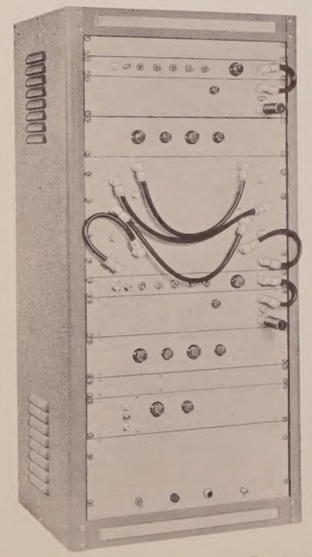


TWO TIME DELAY GENERATORS

Model A-2 **Model A-4**

Feature: Low jitter. Linear scales. Small repetition rate effects. External connector provided for delay voltage so that unit may be externally time modulated. Easily read dial controls.

Price: Model A-2 **$750.00** Model A-4 **$875.00**



HIGH SPEED 10 MEGACYCLE DOUBLE PULSE GENERATOR MODEL B5-2

Both pulse trains are derived from one single oscillator. Its output pulses are adjustable in widths from 20 mμs to 12.5 μs with rise and fall time no greater than 8 mμs. Maximum pulse width is restricted to about 20% of the pulse to pulse spacing. (Duty cycle .20 or less). Continuously variable repetition rate, pulse width and pulse delay permit the study of high speed switching circuits.

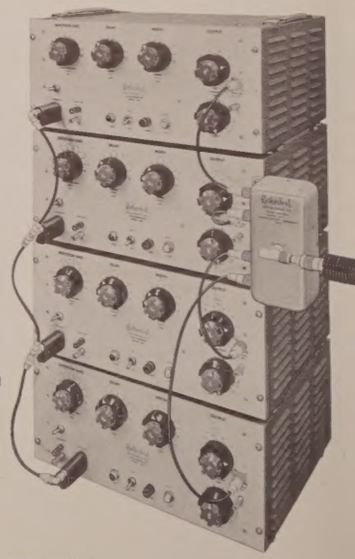
Price: **$3.975.00**

MULTI-PULSE Rutherford HIGH REPETITION RATE MULTI-PULSING SYSTEM at low cost!

4 MODEL B7-B with the use of a MIXING NETWORK produces 4 INDIVIDUAL PULSES of various specifications. The stacked units may be placed in a 19" rack type cabinet. Each of the four B7-B models can be disassembled and returned to laboratories for use as individual pulse generators.

Price: **$720.00** each,

MIXER ASSEMBLY - **$75.00**



All prices F. O. B. Culver City, California

For detailed specifications on Rutherford pulse instrumentation write for complete bulletin.

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Represented in Your Area by...

PART NUMBERS FOR TERMINATIONS

PART NO.	CONNECTORS	IMPEDANCE	WATTAGE	PRICE	PART NO.	CONNECTORS	IMPEDANCE	WATTAGE	PRICE
K001-1	N (Male)	50 ohms	2*	35.00	K002-11	C (Male)	50 ohms	5*	40.00
K001-2	N (Male)	75 ohms	2*	37.50	K002-12	C (Male)	75 ohms	5*	42.00
K001-3	N (Male	93 ohms	2*	37.50	K002-13	C (Male)	93 ohms	5*	42.00
K001-4	N (Male)	125 ohms	2*	39.00	K002-14	C (Male)	125 ohms	5*	45.00
K001-5	N (Male)	185 ohms	2*	39.00	K002-15	C (Male)	185 ohms	5*	45.00
K001-6	N (Female)	50 ohms	2*	35.00	K002-16	C (Female)	50 ohms	5*	40.00
K001-7	N (Female)	75 ohms	2*	37.50	K002-17	C (Female)	75 ohms	5*	42.00
K001-8	N (Female)	93 ohms	2*	37.50	K002-18	C (Female)	93 ohms	5*	42.00
K001-9	N (Female)	125 ohms	2*	39.00	K002-19	C (Female)	125 ohms	5*	45.00
K001-10	N (Female)	185 ohms	2*	39.00	K002-20	C (Female)	185 ohms	5*	45.00
K001-11	C (Male)	50 ohms	2*	35.00	K003-1	N (Male)	50 ohms	10*	42.50
K001-12	C (Male)	75 ohms	2*	37.50	K003-2	N (Male)	75 ohms	10*	45.00
K001-13	C (Male)	93 ohms	2*	37.50	K003-3	N (Male)	93 ohms	10*	45.00
K001-14	C (Male)	125 ohms	2*	39.00	K003-4	N (Male)	125 ohms	10*	48.00
K001-15	C (Male)	185 ohms	2*	39.00	K003-5	N (Male)	185 ohms	10*	48.00
K001-16	C (Female)	50 ohms	2*	35.00	K003-6	N (Female)	50 ohms	10*	42.50
K001-17	C (Female)	75 ohms	2*	37.50	K003-7	N (Female)	75 ohms	10*	45.00
K001-18	C (Female)	93 ohms	2*	37.50	K003-8	N (Female)	93 ohms	10*	45.00
K001-19	C (Female)	125 ohms	2*	39.00	K003-9	N (Female)	125 ohms	10*	48.00
K001-20	C (Female)	185 ohms	2*	39.00	K003-10	N (Female)	185 ohms	10*	48.00
K002-1	N (Male)	50 ohms	5*	40.00	K003-11	C (Male)	50 ohms	10*	42.50
K002-2	N (Male)	75 ohms	5*	42.00	K003-12	C (Male)	75 ohms	10*	45.00
K002-3	N (Male)	93 ohms	5*	42.00	K003-13	C (Male)	93 ohms	10*	45.00
K002-4	N (Male)	125 ohms	5*	45.00	K003-14	C (Male)	125 ohms	10*	48.00
K002-5	N (Male)	185 ohms	5*	45.00	K003-15	C (Male)	185 ohms	10*	48.00
K002-6	N (Female)	50 ohms	5*	40.00	K003-16	C (Female)	50 ohms	10*	42.50
K002-7	N (Female)	75 ohms	5*	42.00	K003-17	C (Female)	75 ohms	10*	45.00
K002-8	N (Female)	93 ohms	5*	42.00	K003-18	C (Female)	93 ohms	10*	45.00
K002-9	N (Female)	125 ohms	5*	45.00	K003-19	C (Female)	125 ohms	10*	48.00
K002-10	N (Female)	185 ohms	5*	45.00	K003-20	C (Female)	185 ohms	10*	48.00

CONNECTORS: N (Male) = #UG 21D/U
N (Female) = #UG 23D/U
C (Male) = #UG 573A/U
C (Female) = #UG 572/U

*1000 LFM per minute

ALL DATA SUBJECT TO CHANGE WITHOUT NOTICE

PART NUMBERS FOR ATTENUATORS

PART NO.	CONNECTORS	ATTENUATORS (DB)	WATTAGE	PRICE
M001-1	N	1	4	30.00
M001-2	N	2	4	30.00
M001-3	N	5	4	30.00
M001-4	N	10	2	30.00
M001-5	N	20	1	40.00
M001-6	C	1	4	35.00
M001-7	C	2	4	35.00
M001-8	C	5	4	35.00
M001-9	C	10	2	35.00
M001-10	C	20	1	45.00
M002-1	N	1	15	45.00
M002-2	N	2	15	45.00
M002-3	N	5	10	50.00
M002-4	N	10	10	50.00
M002-5	N	20	5	60.00
M002-6	C	1	15	50.00
M002-7	C	2	15	50.00
M002-8	C	5	10	55.00
M002-9	C	10	10	55.00
M002-10	C	20	5	65.00

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